TRANSPORTATION MATERIALS LABORATORY

LAB MANUAL

Academic Year	:	2019 - 2020
Subject Code	:	ACE110
Regulations	:	IARE – R16
Class	:	B.Tech VI Semeste
Branch	:	CE

Prepared by

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Department of Civil Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad – 500 043

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VISION
To produce eminent, competitive and dedicated civil engineers by imparting latest technical skills and ethical values to empower the students to play a key role in the planning and execution of infrastructural & developmental activities of the nation.

MISSION
To provide exceptional education in civil engineering through quality teaching, state-of-the-art facilities and dynamic guidance to produce civil engineering graduates, who are professionally excellent to face complex technical challenges with creativity, leadership, ethics and social consciousness.

Program Outcomes (PO's)	
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The Program Specific outcomes (PSO's) listed below were developed specifically to meet the Program Educational Objectives (PEO's). The focus of these PSO's is consistent with the set of required PO's identified in the NBA accreditation guidelines.

The Civil Engineering PSO's require that graduates receiving a Bachelor of Technology in Civil Engineering degree from IARE demonstrate the following.

Program Specific Outcomes – Civil Engineering	
PSO 1	**ENGINEERING KNOWLEDGE** Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.
PSO 2	**BROADNESS AND DIVERSITY** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage
PSO 3	**SELF-LEARNING AND SERVICE** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

EXPT.No.	CE	
	Program Outcomes Attained	Program Specific Outcomes Attained
I	PO1, PO2	-
II	PO1, PO2	PSO1
III	PO1,PO2	-
IV	PO1,PO2	PSO1
V	PO1,PO2	-
VI	PO1,PO2	PSO1
VII	PO1,PO2	-
VIII	PO1,PO2	PSO1
IX	PO1, PO2,PO3	PSO1
X	PO2,PO3	PSO1
XI	PO1,PO2	-
XII	PO3,PO4	PSO1
XIII	PO2,PO3	-
XIV	PO2,PO3	PSO1
XV	PO1,PO2	-
XVI	PO3,PO4	PSO1
XVII	PO2,PO3	-

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Certificate

This is to certify that it is a bonafied record of Practical work done by Sri/Kum. _____ bearing the Roll No. _____ of _____ class _____ branch in the _____ laboratory during the academic year _____ under our supervision.

Head of the Department

Lecture In-Charge

External Examiner

Internal Examiner

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Transportation Material Testing Lab Do's and Don'ts

The chemistry laboratory must be a safe place in which to work and learn about chemistry. Most of these involve just using common sense.

1. Students should report to the labs concerned as per the timetable.
2. Record should be updated from time to time and the previous experiment must be signed by the faculty in charge concerned before attending the lab.
3. Students who turn up late to the labs will in no case be permitted to perform the experiment scheduled for the day.
4. After completion of the experiment, certification of the staff in-charge concerned in the observation book is necessary.
5. Students should bring a notebook of about 100 pages and should enter the readings/observations/results into the notebook while performing the experiment.
6. The record of observations along with the detailed experimental procedure of the experiment performed in the immediate previous session should be submitted and certified by the staff member in-charge.
7. Not more than FIVE students in a group are permitted to perform the experiment on a set up.
8. The group-wise division made in the beginning should be adhered to, and no mix up of student among different groups will be permitted later.
9. The components required pertaining to the experiment should be collected from Lab- in-charge after duly filling in the requisition form.
10. When the experiment is completed, students should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.
11. Any damage of the equipment or burnout of components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year.
12. Students should be present in the labs for the total scheduled duration.
13. Students are expected to prepare thoroughly to perform the experiment before coming to Laboratory.
14. Procedure sheets/data sheets provided to the students groups should be maintained neatly and are to be returned after the experiment.

DRESS CODE:

1. Boys - Formal dress with tuck in and safety shoes.
2. Girls - Formal dress (salwar kameez) and safety shoes.
3. Apron in blue color for both boys and girls.
4. Wearing of jeans is strictly prohibited

Importance of Transportation Material Testing:

Transportation materials lab deals with testing of pavement material used for construction in day to day activities as per IS standards.

It mainly deals with

1. Identify the properties and behavior of highway material for different loading patterns in terms of crushing and impact loads
2. Demonstrate tests on transportation materials like aggregate, bitumen, sand etc and check their strength and suitability
3. Understand the properties of cement by conducting setting time, specific gravity and compressive strength tests.
4. Measure and calculate flakiness and elongation properties of coarse aggregates
5. From the calculated result we can justify the material properties which help us to evaluate the pavement properties.

Experiment No: I

INTRODUCTION TO TRANSPORTATION MATERIALS LABORATORY – I

Transportation materials lab deals with testing of pavement material used for construction in day to day activities as per IS standards.

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Experiment No: II

AGGREGATE CRUSHING STRENGTH TEST

Theory and Scope:

1 This is one of the major Mechanical properties required in a road stone. The test evaluates the ability of the Aggregates used in road construction to withstand the stresses induced by moving vehicles in the form of crushing. With this the aggregates should also provide sufficient resistance to crushing under the roller during construction and under rigid tyre rims of heavily loaded animal drawn vehicles.

2 The crushing strength or aggregate crushing value of a given road aggregate is found out as per IS-2386 Part- IV.

3 The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement aggregate possessing low aggregate crushing value should be preferred.

4 The aggregate crushing value of the coarse aggregates used for cement concrete pavement at surface should not exceed 30% and aggregates used for concrete other than for wearing surfaces, shall not exceed 45% as specified by Indian Standard (IS) and Indian Road Congress (IRC).

Aim:

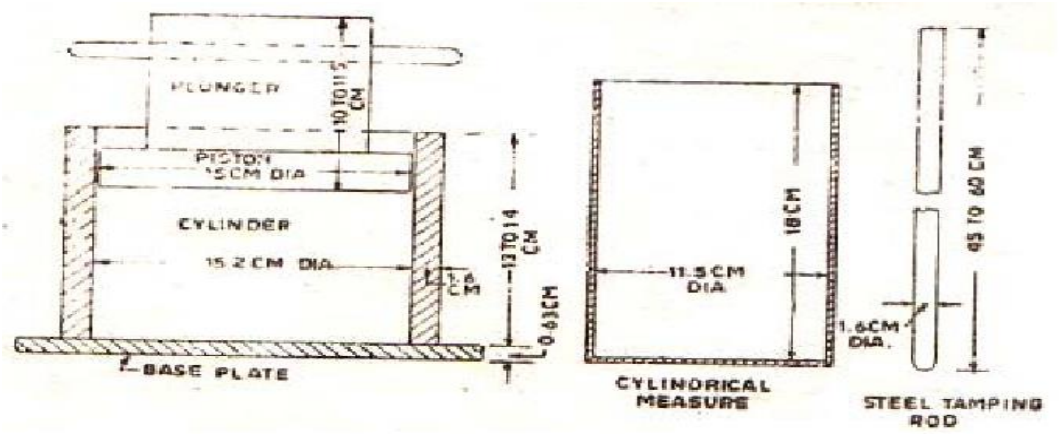
To determine crushing strength of a given aggregate as per **IS: 2386 part - IV**

Apparatus:

- A steel cylinder of internal diameter 15.2 cm (Steel cylinder with open ends)
- A square base plate, plunger having a piston diameter of 15 cm.
- A cylindrical measure of internal diameter of 11.5 and height 18 cms.
- Steel tamping rod having diameter of 1.6 cms length 45 to 60 cms.
- Balance of capacity 3 kg with accuracy up to 1 gm.
- Compression testing machine capable of applying load of 40 tonnes at a loading rate tonnes per minute

Procedure:

- The aggregate in surface-dry condition before testing and passing 12.5 mm sieve and retained on 10 mm sieve is selected.
- The cylindrical measure is filled by the test sample of the aggregate in three layers of approximately equal depth, each layer being tamped 25 times by the rounded end of the tamping rod.
- After the third layer is tamped, the aggregates at the top of the cylindrical measure are leveled off by using the tamping rod as a straight edge. Then the test sample is weighed. Let that be w_1 gm.
- Then the cylinder of test apparatus is kept on the base plate and one third of the sample from cylindrical measure is transferred into cylinder and tamped 25 times by rounded end of the tamping rod.
- Similarly aggregate in three layers of approximately equal depth, each layer being tamped 25 times by rounded end of the tamping rod.
- Then the cylinder with test sample and plunger in position is placed on compression testing machine.
- Load is then applied through the plunger at a uniform rate of 4 tonnes per minute until the total load is 40 tonnes and the load is released.
- Aggregates including the crushed position are removed from the cylinder and sieved on a 2.36mm IS Sieve and material which passes this sieve is collected and weighed. Let this be w_2 gm.
- The above step is repeated with second sample of the same aggregate. The two tests are made for the same specimen for taking an average value.
- Total weight of dry sample taken is w1gm. weight of the portion of crushed material passing 2.36mm IS sieve be w2 gm. Then the aggregate crushing value is defined as the ratio of weight of fines passing the specified IS sieve to the total weight of the sample (w1).
  Aggregate crushing value = 100*w2/w1%



Aggregate Crushing Test Apparatus

Observation and Calculation:

Trials	Total Weight of dry aggregate sample 10 gm	Weight of fines passing 2.36mm IS sieve, w2gm	Aggregate crushing value %	Average aggregate crushing strength value
1				
2				

Aggregate crushing value = 100*w_2/w_1.

Result:

The mean (average) of the crushing value aggregate is _____%

Viva voce:

1. What do you understand by the term "Ten percent Fines value"?
2. Define aggregate crushing value and how crushing strength test is carried out on cylindrical stone specimen explain.
3. What is the use or application of the aggregate crushing test?

Experiment No: III

AGGREGATE IMPACT TEST

Theory and Scope:

Toughness is the property of a material to easiest impact. Due to moving loads the aggregates are subjected to pounding action or impact and there is possibility of stones breaking into smaller pieces. Therefore a test designed to evaluate the toughness of stones i.e., the resistance of the stones to fracture under repeated impacts may be called Impact test on aggregates. The test can also be carried on cylindrical stone specimen known as Page Impact test. The aggregate Impact test has been standardized by Indian Standard Institution. The aggregate impact test is conducted as per **IS-2386 Part IV**.

The aggregate Impact value indicates a relative measure of the resistance of aggregate to a sudden shock or an Impact, which in some aggregates differs from its resistance to a slope compressive load in crushing test. A modified Impact test is also often carried out in the case of soft aggregates to find the wet Impact value after soaking the test sample.

Various agencies have specified the maximum permissible aggregate Impact values for the different types of pavements. IRC has specified the following values.

The maximum allowable aggregate Impact value for water bound Macadam; Sub-Base coarse 50% where as cement concrete used in base course is 45%. WBM base course with Bitumen surface in should be 40%. Bituminous Macadam base course should have A.I.V of 35%. All the surface courses should possess an A.I.V below 30%.

Aim: To determine the aggregate impact value of given aggregate as per I.S-2386 Part IV.

Apparatus:

The apparatus consists of an

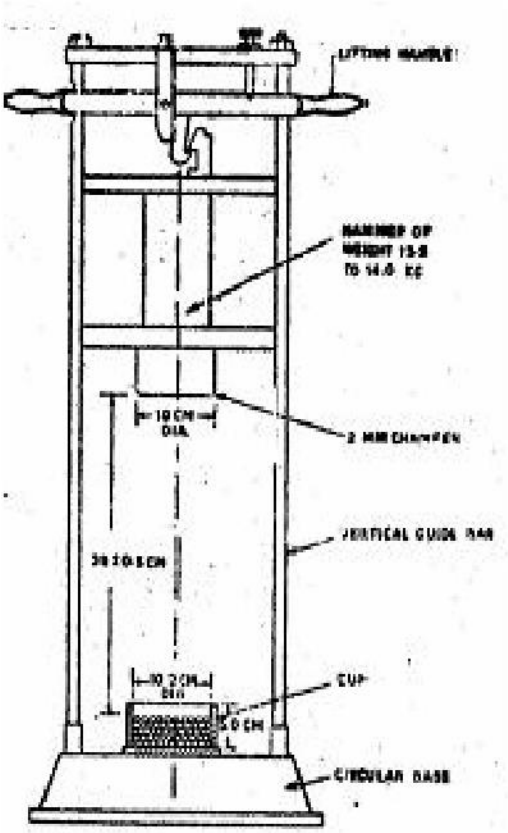
- Impact testing machine: The machine consists of a metal base. A detachable cylindrical steel cup of internal diameter 10.2cm and depth 5cm. A metal hammer of weight between 13.5 to 14Kg, 10cm in diameter and 5cm long. An arrangement for raising the hammer and allow it to fall freely between vertical guides from a height of 38cm on the test sample in the cup.
- A cylindrical metal measure having 7.5cm and depth of 5cm for measuring aggregates.
- A tamping rod of circular cross section, 1cm in diameter and 23cm long, rounded at one end.

- I.S. sieve of sizes 12.5mm, 10mm and 2.36mm.
- Balance of capacity not less than 500gm to weigh accurate up to 0.01gm.

Procedure:

- The test sample consists of aggregates passing 12.5mm sieve and retained on 10mm sieve and dried in an oven for 4 hours at a temperature of 100 C to 110 C.
- The aggregates are filled upto about 1/3 full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod.
- The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times.
- The overflow of aggregates in cylindrically measure is cut off by tamping rod using it has a straight edge.
- Then the entire aggregate sample in a measuring cylinder is weighted nearing to 0.01gm.
- The aggregates from the cylindrical measure are carefully transferred into the cup which is firmly fixed in position on the base plate of machine. Then it is tamped 25 times.
- The hammer is raised until its lower face is 38cm above the upper surface of aggregates in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate is than removed from the cup and the whole of it is sieved on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample.
- Let the original weight of the oven dry sample be $w_1$gm and the weight of fraction passing 2.36mm I.S sieve be $w_2$gm. Then aggregate Impact value is expressed as the % of fines formed in terms of the total weight of the sample.

$$\text{Aggregate Impact Value} = 100 * W2/W1\% .$$



Observation and Calculation:

Sl. No.	Details of Sample	Trail 1	Trail 2	Average
1	Total Weight of aggregate sample filling the cylinder measure = W_1 g			
2	Weight of aggregate passing 2.36 mm sieve after the test = W_2 g			
3	Weight of aggregate retained 2.36 mm sieve after the test =W_2 g			
4	(W_1-W_2 + W_2)			
5	Aggregate Impact Value =(W_2/W_1)*100 Percent			

Result:

The mean A.I.V is _____%.

Viva voce:

1. How is aggregate Impact expressed?
2. What do you understand by dry and wet Impact value?
3. Aggregate Impact value of material A is 15 and that of B is 35. Which one is better for surface course?

Experiment No: IV

SPECIFIC GRAVITY AND WATER ABSORPTION TEST

Aim: To find out the specific gravity and water absorption of the given aggregate

Apparatus:

1. Balance
2. Oven to maintain temp of 100^oC to 110^oC
3. Wire basket
4. Container with water
5. Trays

Procedure:

About 2 Kg of the aggregate sample is washed thoroughly and placed in the wire basket when immersed in distilled water. The basket and the sample are then weighed (W_1) while suspended in water at a temp of 22^oC to 32^oC. The aggregatges are then placed on the absorbent clothes and should be cleaned. The surface dry aggregates is then weighed (W_2). The aggregate is placed in a shallow tray and kept in an oven maintained at a temp of 110^oC for 24 hours. It is then removed from the oven, cooled in an air tight container and weighted (W_4).

Observations:

Weight of saturated aggregate suspended in water with the basket = W_1

Weight of basket above suspended in water = W_2

Weight of saturated aggregate in water = $(W_1 - W_2)$

Weight of saturated surface dry aggregate in air = W_3

Weight of Water equal to the volume of the aggregate = $W_3 - W_5$

Calculations:

Specific Gravity= dry weight of aggregate/ weight of equal volume of water = $\frac{W_4}{W_3 - W_5}$

Water Absorption, % = Percentage by weight of water absorbed in terms of oven dried weight of aggregate

$$= \frac{W_3 - W_4}{W_4} x100$$

Interference:

The specific gravity of aggregates normally used in road construction ranges from about 2.5 to 3.0 with an average value of 2.68. Water absorption value ranges from 0.1 to 2.0 % for aggregates normally used in road surfacing IRC has specified the maximum water absorption valves as 10 percent for aggregate used in bituminous surface dressing and built up spray grow.

Results:

The specific gravity and water absorption of the given aggregate are _____

Experiment No: V

ATTRITION TEST OF COARSE AGGREGATES

Aim:

Determination of the percentage of deleterious material in ice control sands by carrying out the Attrition test.

Apparatus

Drying oven: A thermostatically controlled drying oven capable of being maintained continuously at a temperature of 110 ± 5°C

- Balance: sensitive to 0.1 g and having a capacity of 1000 g.
- Sieve: 75 µm.
- Containers: suitable for drying test samples.
- Attrition machine: Conforming in all its essential characteristics to the design shown

The machine shall consist of a vertical shaft with paddles attached at one end. The other end shall be attached to an electric motor capable of rotating the shaft at a speed of 390 ± 10rpm under load.

Test sample

Samples for attrition are to be obtained from materials to be tested by use of a sample splitter or the method of quartering. The test sample shall be the end result of the sampling method and, when dry, should weigh between 490 and 520 g. Under no circumstances should an attempt be made to select samples of an exact predetermined mass.

Procedure

- Ovens dry the test sample to constant mass. Weigh to the nearest 0.1 g and record the masses the original mass.
- Set the Attrition test sample tank so that there is a clearance of 5 mm between the bottom of the attrition shaft and the bottom of the tank.
- Place the test sample in the tank and add 175 ml of water and cover with the lid. Run the attrition machine at 390 rpm for 10 min.
- Lower the tank, wash the material on the lid and paddles into the tank with a wash bottle and wash the sample onto a 75 µm sieve
- Wash the sample over the 75 µm sieve as described in MTO Test Method LS-602 and oven dry the material retained to constant mass
- Weigh the oven-dry sample to the nearest 0.1 g

Calculation

Calculate the percentage of deleterious material (loss by attrition and washing) as follows

$A = \frac{\text{mass of pass 75 µm sieve}}{\text{Mass of original sample}} \times 100 = \frac{W_1 - W_2}{W1} \times 100$

Where: A = loss by attrition and washing, percent

W_1= original mass of sample, g

W_2 = mass of retained 75 µm sieve after washing, g

Reporting of results

Report the percentage of deleterious material to the nearest 0.1 percent

GENERAL NOTES

- Care should be taken to ensure that there is no loss of material or water by splashing in the Attrition machine and that all material is washed from the attrition paddles into the sample tank.
- Tap water at room temperature may be used in the test. It is important that exactly 175 ml of water is used since smaller or greater values may have a significant effect on the test result.
- This test includes the pass 75 µm material in the original sample as deleterious material.
- Since a 500 g sample is used, the washing procedure after test may not remove all the pass75 µm material from very fine sands. If this is suspected, the oven dry sample, after test, should bere-sieved. Any additional pass 75 µm material should be discarded, and the oven dry sample mass (retained) used for calculation purposes. A note should be made on the data card.

Precision

Two test results on a sample of sand should not have a difference of greater than one percent. If a greater difference than one percent is obtained, the sample should be re-tested.

ATTRITION TEST

Lab No.	ORIGINAL MASS g	MASS AFTER TEST g	LOGG g	PERCENT LOSS
Date :		**Operator :**		
Remarks				

Experiment No: VI

ABRASION TEST OF COARSE AGGREGATES

Theory and Scope:

Abrasion is a measure of resistance to wear or hardness. It is an essentially property for road aggregates especially when used in wearing coarse. Due to the movements of traffic, the road stones used in the surfacing course are subjected to wearing actions at the top. When traffic moves on the road the soil particle (sand) which comes between the wheel and road surface causes abrasion on the road stone. The abrasion test on aggregate is found as per **I.S.-2386 part-IV.**

Abrasion tests on aggregates are generally carried out by any one of the following methods-

1. Los Angeles abrasion test.
2. Deval abrasion test.
3. Dorry abrasion test.

Los Angeles Abrasion Test: - The principle of Los Angeles abrasion test is to find thepercentage wear due to the relative rubbing action between the aggregates and steel balls used as abrasive charge pounding action of these balls also exist while conducting the test. Maximum Allowable Los Angeles Abrasion Values of Aggregates in Different

Types of pavement layers as per Indian Road Congress (IRC) are:-

For sub-base course a value of 60%. For base course such as WBM, Bituminous Macadam (B.M.), Built - Up spray grout base course and etc. value of 50%.

For surface course such as WBM, BM, Bituminous Penetration Macadam, Built-Up spray grout binder course and etc. a value of 40%.

If aggregates are used in surface course as bituminous carpet, bituminous surface dressing, single or two coats, cement concrete surface coarse and etc. a value of 35%.

If aggregates are used for bituminous concrete, Cement concrete pavement as surface coarse than aggregate abrasion value of 30% maximum.

Aim: To determine the abrasion value of given aggregate sample by conducting Los Angeles Abrasion Test.

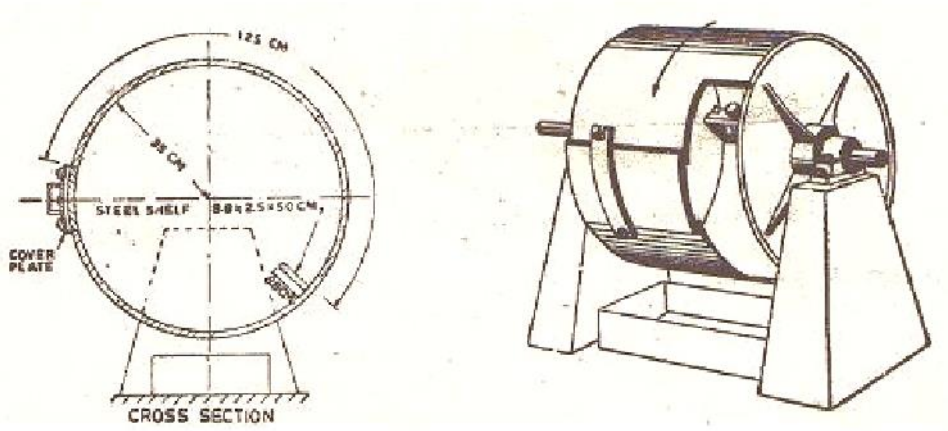
Apparatus:

- Los Angeles machine with inside diameter 70cm and inside length of 50%.Abrasive charges.
- I.S Sieve with 1.7mm opening.
- Weighting Balance of 0.1gm accuracy.

Procedure:

- Clean and dry aggregate sample confirming to one of the grading A to G is used for the test. (Refer table no. 1)
- Aggregates weighing 5Kg for grading A, B, C or D and 10Kg for grading's E, F or G may be taken as test specimen and placed in the cylinder.
- The abrasive charge is also chosen in accordance with table no.1 and placed in the cylinder of the machine, and cover is fixed to make dust tight. The machine is rotated at a speed of 30 to 33 revolutions per minute.
- The machine is rotated for 500 revolutions for grading's A, B, C and D, for grading's E, F and G, it shall be rotated for 1000 revolutions.
- After the desired number of revolutions, the machine is stopped and the material is discharged from the machine taking care to take out entire stone dust.
- Using a sieve of size larger than 1.70mm I.S sieve, the material is first separated into two parts and the finer position is taken out and sieved further on a 1.7mm I.S sieve.
- Let the original weight of aggregate be $w_1$gm, weight of aggregate retained on 1.70mm I.S sieve after the test be $w_2$gm.

$$\text{Los Angeles abrasion value } \% = \frac{w_1 - w_2}{w_1} x 100 .$$



Schematic Diagram of Los Angeles Abrasion Testing Machine

Los Angeles Abrasion Testing Machine

Observation and Calculation:

Sl No.	Details of Sample	Trail 1	Trail 2	Average
1	Weight of Specimen = W_1 g			
2	Weight of Specimen after abrasion test, coarser than 1.70mm IS sieve = W_2 g			
3	Percentage wear = $((W_1 - W_2)/W_1) * 100$			

Table

Grading	Weight in grams of each test sample in the size range, mm (Passing and retained on Square holes)										Abrasive Charge	
	80-63	63-50	50-40	40-25	25-20	20-12,5	20-5-10	10-6.3	6.3-4.75	4.75-2.36	No. of Sph-eres	Weight of Charge,g
A				1250	1250	1250	1250				12	5000+25
B						2500	2500				11	4584+25
C								2500	2500		8	3330+20
D										2500	6	2500+15
E	2500	2500	5000								12	5000+25
F			5000	5000							12	5000+25
G				5000	5000						12	5000+25

Result:

The average value of two Los Angeles abrasion test is _____%

Viva voce:

1. The abrasion value found from Los Angeles test for two aggregates A and B are 50% and 38% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?
2. Why Los Angeles abrasion test is considered superior to the other form of tests which are used to determine the hardness of aggregates?
3. Two materials have abrasion values 3 and 10 respectively. Which one is harder and why?

Experiment No: VII

SHAPE TESTS OF COARSE AGGREGATES

Theory and Scope:

The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. In case of gravel it is determined by its Angularity Number. Flakiness and Elongation tests are conducted on coarse aggregates to assess the shape of aggregates. Aggregates which are flaky or elongated are detrimental to the higher workability and stability of mixes. They are not conducive to good interlocking and hence the mixes with an excess of such particles are difficult to compact to the required degree. For base coarse and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with probabilities of breaking down under heavy loads. Rounded aggregates are preferred in cement concrete road construction as the workability of concrete improves. Angular shape of particles are desirable for granular base coarse due to increased stability derived from the better interlocking when the shape of aggregates deviates more from the spherical shape, as in the case of angular, flaky and elongated aggregates, the void content in an aggregate of any specified size increases and hence the grain size distribution of the graded aggregates has to be suitably altered in order to obtain minimum voids in the dry mix or the highest dry density. It is determined according to the procedure laid down in **IS-2386 (PART- I).**

FLAKINESS INDEX: The flakiness index of aggregates is the percentage by particles whose least dimension (thickness) is less than $3/5^{th}$ (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

ELONGATION INDEX: The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than 1 and $4/5^{th}$ times (1.8 times) their mean dimensions. The elongation test is not applicable to sizes smaller than 6.3mm.

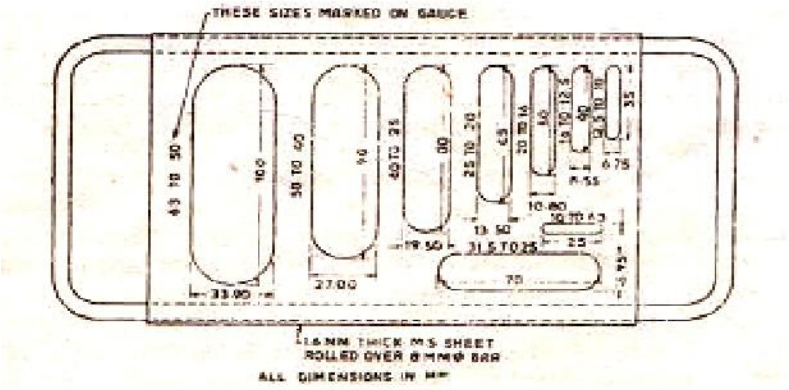
ANGULARITY NUMBER: The angularity number of an aggregate is the amount by which the percentage voids exceeds 33 after being compacted in a prescribed manner. The minimum allowable combined index of aggregates used in surface course of pavement is30%

Aim: - To determine the flakiness Index of a given aggregates sample.

Apparatus: - The apparatus consists of a standard thickness gauge, I.S. sieves of sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3mm and a balance to weigh the samples.

Procedure:

- The sample is sieved with the sieves mentioned in the table.
- A minimum of 200 pieces of each fraction to be tested are taken and weighed (w1gm).
- In order to separate flaky materials, each fraction is then gauged for thickness on
- Thickness gauge, or in bulk on sieve having elongated slots as specified in the table.
- Then the amount of flaky material passing the gauge is weighed to an accuracy of at least 0.1% of test sample.
- Let the weight of the flaky materials passing the gauge be w1gm. Similarly the weights of the fractions passing and retained on the specified sieves be w1, w2, w3, etc. are weighed and the total weight w1+w2+w3+……. = wg is found. Also the weights of the materials passing each of the specified thickness gauge are found = W1, W2, W3… and the total weight of the material passing the different thickness gauges = W1+W2+W3+……. =Wg is found.
- Then the flakiness index is the total weight of the flaky material passing the various thickness gauges expressed as a percentage of the total weight of the sample gauged



Thickness Gauge

Flakiness Index Test in Progress

SIZE OF AGGREATE		THICKNESS GAUGE (O.6 TIMES THE MEAN SIEVE)mm	Weight of the faction consisting of at least 200 pieces in gm.	Weight of aggregates in each fraction passing thickness gauge in gm.
PASSING THROUGH I.S SIEVE mm	RETAINED ON I.S. SIEVE mm			
63	50	33.90		
50	40	27.00		
40	25	19.50		
31.5	25	16.95		
25	20	13.50		
20	16	10.80		
16	12.5	8.55		
12.5	10.0	6.75		
10	6.3	4.89		

Result: The flakiness index of the given sample of aggregates is _____%.

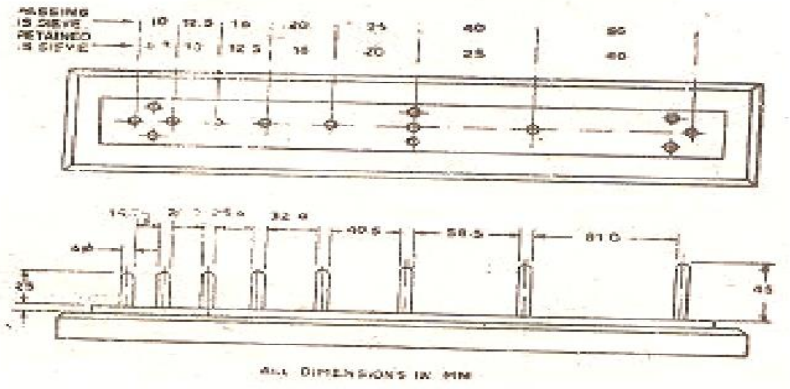
SHAPE TEST *(Elongation Index)*

Aim: To determine the Elongation Index of the given aggregate sample.

Apparatus: Length gauge, I.S-sieves as given in the table and a balance of accuracy 0.01 Gm.

Procedure:

- The sample is sieved through I.S-sieves specified in the table. A minimum of 200 aggregate pieces of each fraction is taken and weighed.
- Each fraction is thus gauged individually for length in a length gauge. The gauge length is used should be those specified in the table for the appropriate material.
- The pieces of aggregates from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and they are collected separately to find the total weight of aggregate retained on the length gauge from each fraction.
- The total amount of elongated material retained by the length gauge is weighed to an accuracy of at least 0.1% of the weight of the test sample.
- The weight of each fraction of aggregate passing and retained on specified sieves
- sizes are found - W_1, W_2, W_3, ……. And the total weight of sample determined = $W_1+W_2+W_3+$……. = Wg. Also the weights of material from each fraction retained on the specified gauge length are found = x_1, x_2, x_3… and the total weight retained determined = $x_1+x_2+x_3+$…… = x gm.
- The elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged.



Length Gauze

Elongation Index Test in Progress

SIZE OF AGGREATE		LENGTH GAUGE (1.8 TIMES THE MEAN SIEVE)mm	Weight of the faction consisting of atleast 200 pieces in gm.	Weight of aggregates in each fraction passing thickness gauge,gm.
PASSING THROUGH I.S SIEVE mm	RETAINED ON I.S SIEVE mm			
63	50			
50	40	81.00		
40	25	58.50		
31.5	25	-		
25	20	40.50		
20	16	32.40		
16	12.5	25.60		
12.5	10.0	20.20		
10	6.3	14.70		

Result: The elongation index of a given sample of aggregate is _____%.

Experiment No: VIII

PENETRATION TEST OF BITUMINOUS MATERIALS

Theory and Scope:

The consistencies of bituminous materials vary depending upon several factors such as constituents, temperature, etc. As temperature ranges between 25º and 50ºC most of the paving bitumen grades remain in semi-solid or in plastic states and their viscosity is so high that they do not flow as liquid. Determination of absolute viscosity of bituminous material is not so simple. Therefore the consistency of these materials is determined by indirect methods. The consistency of bitumen is determined by penetration test which is a very simple test. Various types and grades of bituminous materials are available depending on their origin and refining process. The penetration test determines the consistency of these materials foe the purpose of grading them, by measuring the depth (in units of one tenth of a millimeter or one hundredth of a centimeter) to which a standard needle will penetrate vertically under specified conditions of standard load, duration and temperature. Thus the basic principle of the penetration test is the measurement of the penetration (in units of one tenth of a mm) of a standard needle in a bitumen sample maintained at 25C during five seconds, the total weight of the needle assembly being 100gm. The softer the bitumen, the greater will be the penetration. The test is conducted as per IS-1203 for paving bitumen.

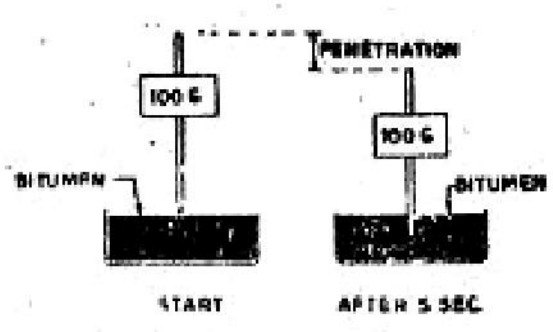
Aim: To determine the grade of a given binder.

Apparatus: It consists of items like container, needle, water bath, penetrometer, stop watch etc. Container is 55mm in diameter and 35mm to 57mm height. The needle is provided With a shank approximately 3.0mm in diameter into which it is immovably fixed.

Procedure:

- The bitumen is softened to a paving consistency between 75º and 100ºC above the approximate temperature at which bitumen softens.
- The sample material is thoroughly stirred to make it homogeneous and free from air bubbles and water.
- The sample containers are cooled in atmosphere of temperature not lower than 13ºC for one hour. Then they are placed in temperature controlled water bath at a temperature of 25ºC for a period of one hour.

- The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100gm.
- Using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample.
- The needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle.
- The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is noted.
- Then the needle is released by pressing a button and a stop watch is started. The needle is released exactly for a period of 5.0secs.
- At least 3 measurements are made on this sample by testing at distance of not less than 100mm apart.
- The difference between the initial and final penetration readings are taken as the penetration value.



Penetration Test Concept

Observation and Calculation:

Readings	Trails			Mean Value
	1	2	3	
Penetrometer Dial Initial Reading				
Penetrometer Dial Final Reading				
Penetration Value				

Result:

The average penetration value of a given bitumen sample is _____ and the grade of bitumen is _____.

Viva Voce:

1. What are the applications of penetration test?
2. What do you understand by the term 30/40 bitumen?
3. What are the precautions to be taken while conducting a penetration test?

Experiment No: IX

DUCTILITY TEST OF BITUMINOUS MATERIALS

Theory and Scope:

A certain minimum ductility is necessary for a bitumen binder. This is because of the temperature changes in bituminous mixes and the repeated deformations that occur in flexible pavements due to the traffic loads. It is of significant importance that the binders form ductile thin films around the aggregates. The binder material which does not possess sufficient ductility would crack and thus provide previous pavement surface. This is in turn results in damaging effect to the pavement structure. The ductility is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks. The test is standardized by the **IS: 1208**. The test is conducted at 27º±0.5ºC and a rate of pull of 50±2.5 mm per minute.

Aim: To conduct ductility test on given bitumen sample.

Apparatus: Briquette mould, (length - 75mm, distance between clips - 30mm, width at mouth of clips - 20mm, cross section at minimum width - 10mm x 10mm), Ductility machine with water bath and a pulling device at a pre calibrated rate, a putty knife, thermometer.

Procedure:

The bitumen sample is method to a pouring temperature (75ºC to 100ºC) and poured into the mould assembly and placed on a brass plate, where a solution of glycerin or soap solution is applied at all surfaces of briquette mould exposed to bitumen.

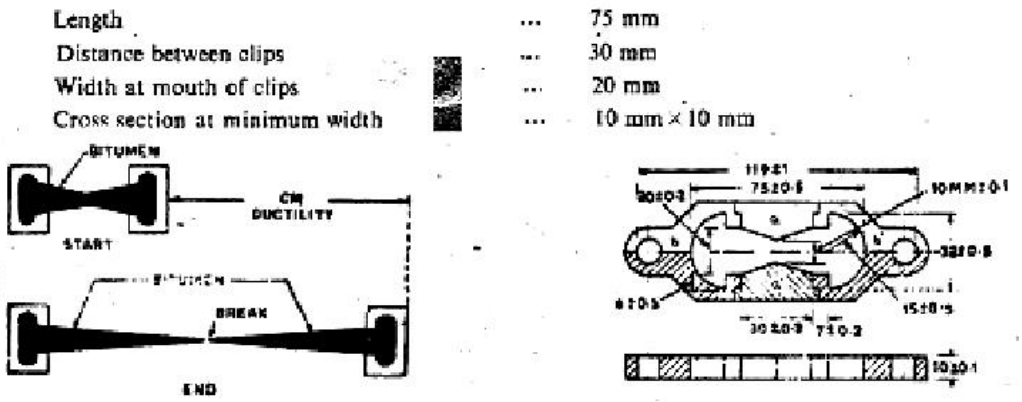
After the sample is poured to the mould, thirty to forty minutes the entire assembly is placed in a water bath at 27ºC.

Then the sample is removed from the water bath maintained at 27ºC and excess bitumen material is cutoff by leveling the surface using hot knife.

After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at 27ºC for 85 to 95 minutes. Then the sides of mould are removed and the clips are carefully booked on the machine without causing any initial strain. Two or more specimens may be prepared in the moulds and clipped to the machine so as to conduct these test simultaneously.

The pointer is set to read zero. The machine is started and the two clips are thus pulled apart horizontally. While the test is in operation, it is checked whether the sample is immersed in water at

depth of at least 10mm. The distance at which the bitumen thread of each specimen breaks is recorded (in cm) to report as ductility value.



Ductility Test Concept

Sample Prepared in Briquette Mould and Ductility Apparatus

Observation and Calculation:
Table

Test Property	Trails			Mean Value
	1	2	3	
Ductility Value				

Result: The ductility value of the given bitumen sample is___ cm.

Viva Voce:

1. List the factors that affect the result of a ductility test.
2. What do you understand by the term repeatability and reproducibility?
3. Explain the significance of ductility test.

Experiment No: X

SOFTENING POINT OF BITUMEN MATERIALS

Theory and Scope:

Bitumen does not suddenly change from solid to liquid state, but as the temperature increase, it gradually becomes soften until it flows readily. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen it is usually determined by Ring and Ball apparatus. The test is conducted as per **IS: 1205**.

Aim:

To determine the softening point of given paving bitumen as per IS: 1205.

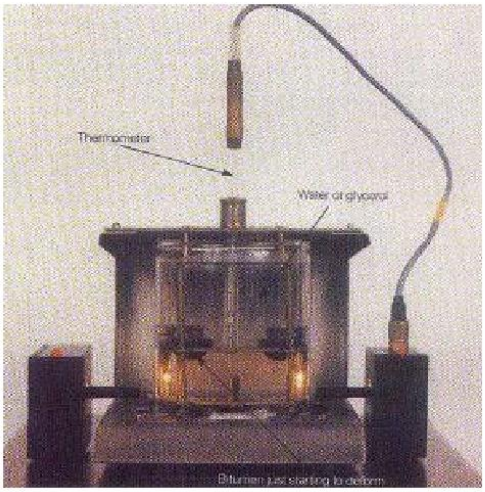
Apparatus:

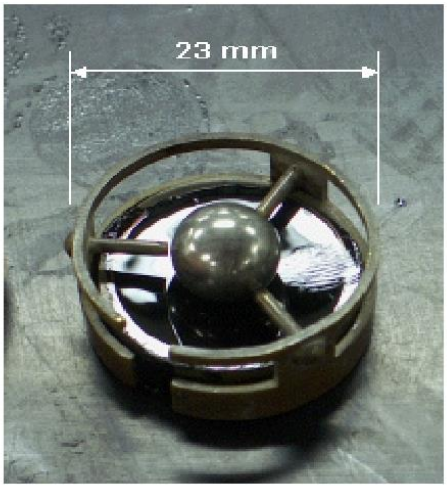
Ring and Ball apparatus, Water bath with stirrer, Thermometer, Glycerin, etc. Steel balls each of 9.5mm and weight of 2.5±0.08gm.

Procedure:

- Sample material is heated to a temperature between 75º and 100ºC above the approximate softening point until it is completely fluid and is poured in heated rings placed on the metal plate.
- To avoid sticking of the bitumen to metal plate, coating is done to this with a solution of glycerin and dextrin.
- After cooling the rings in air for 30 minutes, the excess bitumen is trimmed and rings are placed in the support.
- At this time the temperature of distilled water is kept at 5ºC. This temperature is maintained for 15 minutes after which the balls are placed in position.
- Then the temperature of water is raised at uniform rate of 5ºC per minute with a controlled heating unit, until the bitumen softens and touches the bottom plate by sinking of balls. At least two observations are made. For material whose softening point is above 80ºC, glycerin is used for heating medium and the starting temperature is 35ºC instead of 5ºC.
- The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value.

Softening Test Concept





Softening Point Apparatus and Ring and Ball Guides

Observation and Calculation:

Test Property	Trails			Mean Value
	1	2	3	
Temperature (^{0}C) at which I ball touches the bottom plate				
Temperature (^{0}C) at which II ball touches the bottom plate				
Final Softening Point Temperature				

Result: The softening point value of given bitumen sample is _____ºC and grade of bitumen is _____.

Viva Voce:

1. What are the factors which affect the ring and ball test results?
2. What is softening point?

   If material A has softening point of 56 and B has 42 which binder is good and why?

Experiment XI

FLASH AND FIRE POINT TEST OF BITUMEN MATERIALS

Theory and Scope:

Flash and Fire point test is a safety test conducted on a bituminous material so that it gives an indication of the critical temperature at and above where precautions should be taken to eliminate fire hazards during its applications. Bituminous materials leave out volatiles at high temperature depending upon their grade. These volatile vapors catch fire causing a flash. This condition is very hazardous and it is therefore essential to qualify this temperature for each bitumen grade, so that the paving engineers may restrict the mixing or application temperature well within the limits. Flash and Fire point test is conducted as per **IS: 1209**.

As per IS: 1209 the definitions of flash and fire point are:

Flash Point: "The flash point of a material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified conditions of test".

Fire Point: "The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test".

Aim:

To determine the flash and fire point of a given bituminous material.

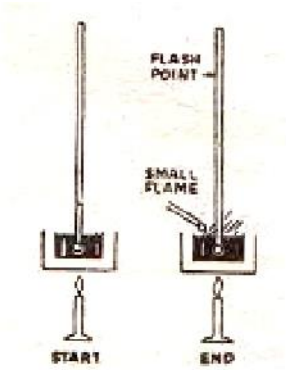
Apparatus:

Pensky-Martens closed cup tester, thermometer, heating source, flame exposure.

Procedure:

- All parts of the cup are cleaned and dried thoroughly before the test is started.
- The material is filled in the cup upto a mark. The lid is placed to close the cup in a closed system. All accessories including thermometer of the specified range are suitably fixed.
- The bitumen sample is then heated. The test flame is lit and adjusted in such a way that the size of a bed is of 4mm diameter. The heating of sample is done at a rate of 5º to 6ºC per minute. During heating the sample the stirring is done at a rate of approximately 60 revolutions per minute.
- The test flame is applied at intervals depending upon the expected flash and fire points

  And corresponding temperatures at which the material shows the sign of flash and fire are noted.



Flash and Fire Point Test Concept

Flash and Fire Point Test in Progress

Observation and Calculation:

Test	Trails			Mean Value
	1	2	3	
Flash Point				
Fire Point				

Result: The temperature at which the flame application that causes a bright flash _____ºC and temperature at which the sample catches fire _____ºC.

Viva Voce:

1. Define flash and fire points.
2. What is the significance of flash and fire point test?
3. What are the parameter that affects the result of flash and fire point tests?

Experiment No: XII

NORMAL CONSISTENCY OF FINENESS OF CEMENT

Theory and Scope:

Standard consistency of cement paste is defined as that consistency which permits the ıical **Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould in this test.** ıical **It is expressed as amount of water as a percentage [by weight] of dry cement. Standard** the **consistency is also called normal consistency.**

Aim:

To determine the percentage of water required for preparing cement paste of standard consistency, used for other tests.

Apparatus:

Vicat apparatus with plunger, I.S. Sieve No. 9, measuring jar, weighing balance

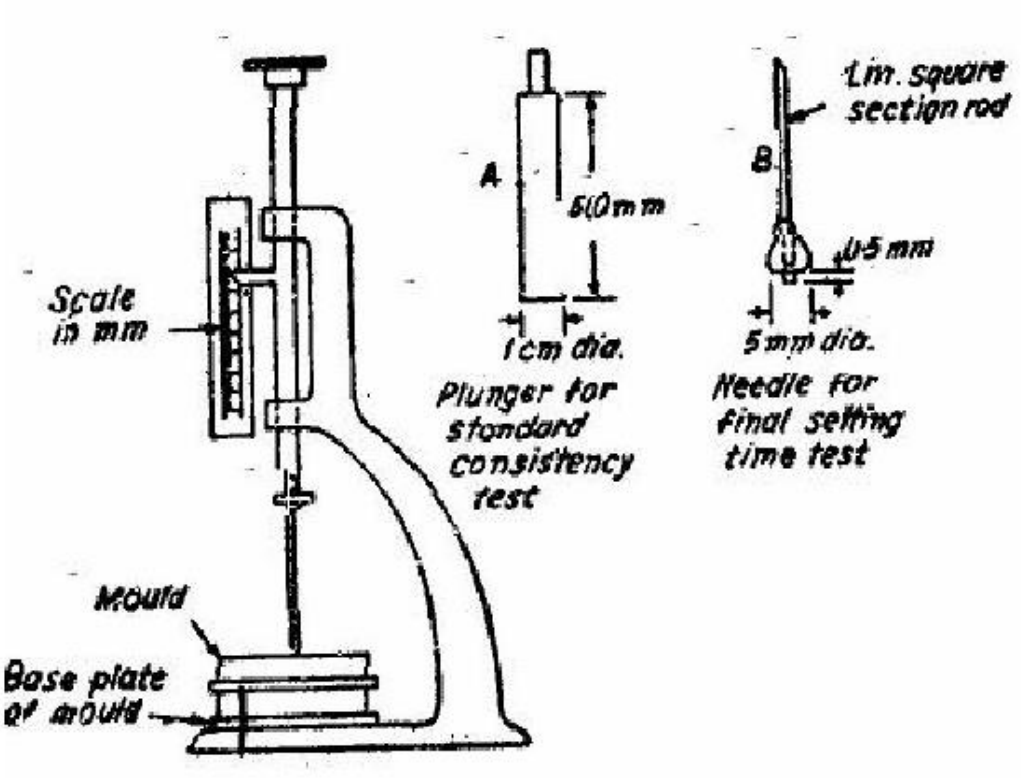
Procedure:

- The vicat apparatus consists of a D- frame with movable rod. An indicator is attached to the movable rod, which gives the penetration on a vertical scale.
- A plunger of 10 mm diameter, 50 mm long is attached to the movable rod to find out normal consistency of cement.
- Take 300 gm of cement sieved through I.S. Sieve No. 9 and add 30% by weight (90 ml) water to it. Mix water and cement on a non-porous surface thoroughly with in 3 to 4 minutes.
- The cement paste is filled in the vicat mould and top surface is leveled with a trowel. The filled up mould shall be placed along with its bottom non-porous plate on the base plate of the vicat apparatus centrally below the movable rod. The plunger is quickly released into the paste. The settlement of plunger is noted. If the penetration is between 33 mm to 35 mm from top (or) 5 mm to 7 mm from the bottom, the water added is correct. If the penetration is less than required, the process is repeated with different percentages of water till the desired penetration is obtained.

Observation and Calculation:

S.No.	Amount of water mixed	Penetration of Plunger from top	Remark

Result: The normal consistency of cement =



Vicat Apparatus

Viva Voce:

1. What is normal or standard consistency of a cement paste?
2. What are the factors affecting the result of the test?
3. What do you understand by the term flash setting?

Experiment No: XIII

INITIAL SETTING TIME AND FINAL SETTING TIME OF CEMENT

Theory and Scope:

Setting means becoming finer and harder, changing from semi liquid state to plastic state and form plastic state to solid state. Mortar or concrete when mixed is in semi liquid state. The chemical action between cement and water starts, and the mixture goes into plastic state.

Aim:

To find initial and final setting times of cement.

Apparatus:

Vicat apparatus with mould, I.S. sieve No. 9, Initial and final setting time needles, measuring jar, weighing balance, etc.

Procedure:

Initial setting time:

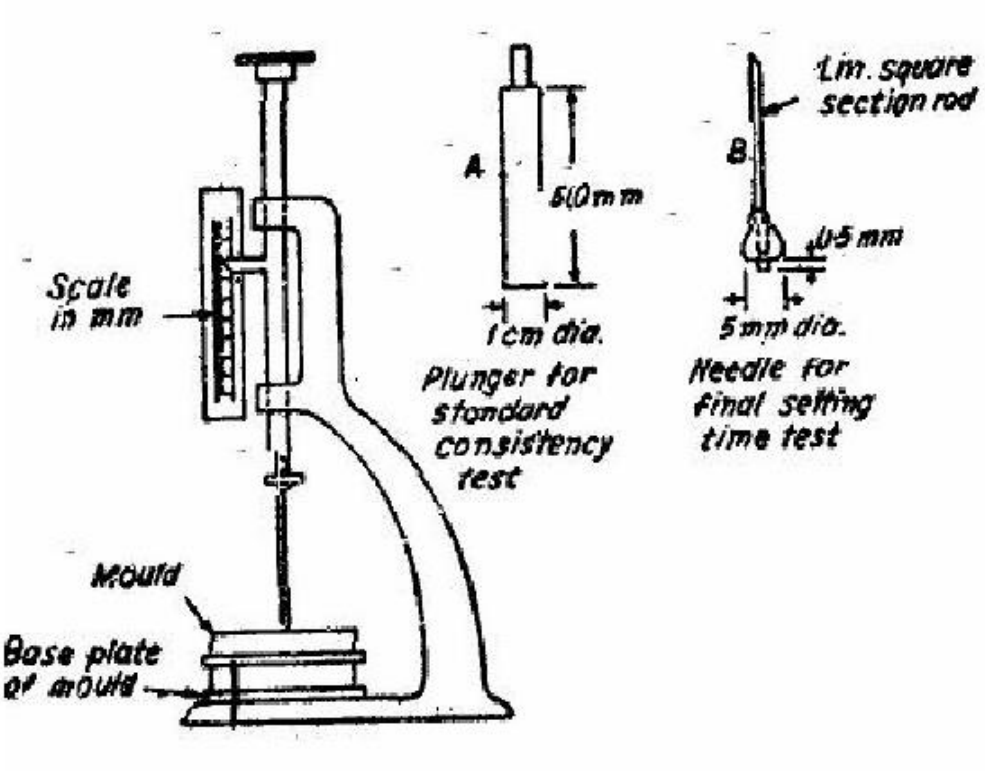
- Initial setting time is defined as the time elapsed between the moment that the water is added to the cement, to the time that the paste starts losing its plasticity i.e. the initial setting time needle fails to penetrate the cement paste kept in the mould by about 33-35 mm from the top or 5-7 mm from bottom of the indicator is called initial setting time.
- Take a cement sample weighing 300 gm, sieved through I.S. sieve No. 9 and mixed with percentage of water as determined in normal consistency test. Stopwatch should be started at the instant when water is added to the cement.
- Prepared cement paste is filled in vicats mould and leveled with trowel. This mould filled with cement paste kept on the non porous plate is now placed under the movable rod with initial setting time needle of cross section 1mm x 1mm
- The needle is quickly released and it is allowed to penetrate the cement paste. In the beginning the needle penetrates completely. It is then taken out and dropped at a fresh place.
- This procedure is repeated at regular intervals till the needle does not penetrate the block for about 5 mm measured from the bottom of indicator. Note the time for initial setting of cement. The initial setting time of an ordinary Portland cement shall not be less than 30 minutes.

Final setting time:

- After noting the time for initial setting of cement, the needle shall be replaced by the final setting time needle.
- The movable rod is slowly released on to the cement paste.
- In the initial stages he needle and collar may pierce through the paste. But after some time the same procedure is followed.
- Such trials shall be carried out until the needle only makes as impression on the top surface of the cement paste and the collar of the needle fails to do so. Note the time for final setting time of cement.
- The final setting time of an ordinary Portland cement shall not be more than 10 hours.

Result: 1. Initial setting time of cement=

2. Final setting time of cement=



Vicat Apparatus

Viva Voce:

1. What is Initial setting time of cement?
2. What is Final setting time of cement?
3. Explain why you are performing this experiment?

Experiment No: XIV

SPECIFIC GRAVITY AND SOUNDNESS OF CEMENT

Theory and Scope:

Unsoundness of cement means, that the cement having excess lime, magnesium sulphates, etc. due to excess of these items there will be volume changes and large expansions, there by reduces the durability of the structures.

AIM: -To find out the soundness of cement.

APPARATUS: - Le-Chatelier Apparatus Cement, Water, Glass plate.

Procedure:-

- The cement is gauged with 0.78 times the water required for standard consistency (0.78P) in a standard manner and filled in to the Le-Chatelier mould kept on the glass plate.
- The mould is covered on the top with another glass plate.
- The whole assembly is immersed in water at temperature of 27oC to 32oC and kept there for 24 hrs.
- Measure the distance between the indicator points.
- Submerge the mould again in water, heat the water up to boiling point in 30 minutes and keep it boiling for 3 hrs.
- Remove the mould from hot water and allow it to cool and measure the distance between the indicator points.
- The distance between these two measurements gives the expansion of cement.
- This must not exceed 10mm for OPC, RHC, LHC, etc.
- If the expansion is more than 10mm, the cement is unsound.

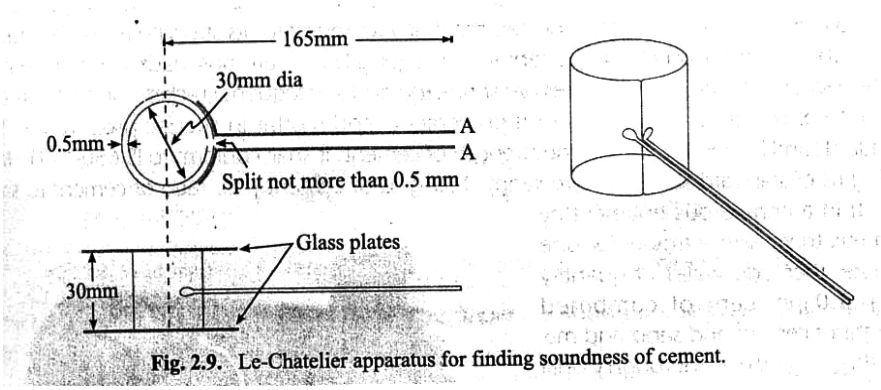


Fig. 2.9. Le-Chatelier apparatus for finding soundness of cement.

Result:

Soundness of given cement =

Viva Voce:

1. What is the significance of this test?

Experiment No: XV

COMPRESSIVE STRENGTH OF CEMENT

Theory and Scope:

The compressive strength of cement mortar is determined strength of

cement mortar is determined in order to verify whether the cement conforms to IS specification **(IS: 269-1976)** and whether it will be able to develop the required compressive strength of concrete. According **to IS: 269-1976**, the ultimate compressive strength of cubes of cement sand mortar of the ratio 1:3, containing (P/4+3.0) percent of water should be as.

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

Apparatus:
Universal Testing Machine or Compression Testing Machine, cube moulds, vibrating machine, crucible for mixing cement and sand measuring cylinder, trowels, non-porous plate and balance with weight box.

Procedure:

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

  Cement = 200 gm.

  Standard Sand = 600 gm.

  Water = (P/4+3.0) percent = 84 gm.

  The time of mixing (gauging) in any event shall not be less than 3 minutes and if the time taken to obtain a uniform colour exceeds 4 minutes the mixture shall be rejected and the operation is repeated with a fresh quantity of cement, sand and water.

- Place the assembled mould on the table of the vibrating machine and firmly hold it in the vibrating machine and firmly hold it in position by means of suitable clamps. Securely attach the hopper at the top of the mould to facilitate filling and this hopper shall not be removed until completion of the vibration period.

- Immediately after mixing the mortar as explained above, fill the entire quantity of mortar

- In the hopper of the cube mould and compact by vibration. The period of vibration shall be 2 minutes at the specified speed of 12000+400 cycles per minute.
- Remove the mould from the machine and keep it at a temperature of 27+ 2^0C in an atmosphere of at least 90 percent relative humidity for 24 hours after completion of vibrations.
- The cubes are removed from the mould and immediately submerge it in clean and fresh water and keep there until taken out just prior to breaking. The water is which the cubes are submerged shall be renewed after every 7 days and be maintained at a temperature of 27+ 2^0C, keep the cubes wet till they are placed in machine for testing.
- Test the specimens at the required periods, test three cubes at the periods mentioned below, the periods being reckoned from the completion of vibration. The compressive strength shall be the average of the strengths of the three cubes for each period.

  a) Ordinary Portland cement: 3 and 7days.

  b) Rapid Hardening Portland cement: 1 and 3 days.

  c) Low Heat Portland Cement: 3, 7 and 28 days.

  The cubes shall be tested on their sides, the load being applied at the rate of 35 N/mm^2/ minute.

Observation and Calculations:

Ordinary Portland cement

S.No.	3-day strength		7-day strength	
	Load in KN	Strength in N/mm^2	Load in KN	Strength in N/mm^2
1				
2				
3				
Average				

Rapid Hardening Cement

S.No.	3-day strength		7-day strength	
	Load in KN	**Strength in N/mm^2**	**Load in KN**	**Strength in N/mm^2**
1				
2				
3				
Average				

Rapid Hardening Cement

S.No.	3-day strength		7-day strength	
	Load in KN	Strength in N/mm^2	Load in KN	Strength in N/mm^2
1				
2				
3				
Average				

Viva Voce:

1. What you understand by term ultimate strength of cement?
2. What precautions do you take during determination of compressive strength?
3. What is the significance of this test?

Experiment No: XVI

COMPRESSIVE STRENGTH OF CONCRETE

Theory and Scope:

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, and quality control during production of concrete etc. Test for compressive strength is carried out either on cube or cylinder. Various standard codes recommends concrete cylinder or concrete cube as the standard specimen for the test

Apparatus for Concrete Cube Test

Compression testing machine

Preparation of Concrete Cube Specimen

The proportion and material for making these test specimens are from the same concrete used in the field Specimen 6 cubes of 15 cm size Mix. M15 or above

Mixing of Concrete for Cube Test

Mix the concrete either by hand or in a laboratory batch mixer

Hand Mixing

- Mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color
- Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch
- Add water and mix it until the concrete appears to be homogeneous and of the desired consistency

Sampling of Cubes for Test

- Clean the mounds and apply oil
- Fill the concrete in the molds in layers approximately 5cm thick
- Compact each layer with not less than 35strokes per layer using a tamping rod (steel bar 16mm diameter and 60cm long, bullet pointed at lower end)
- Level the top surface and smoothen it with a trowel
- Curing of Cubes

- The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

Precautions for Tests

The water for curing should be tested every 7 days and the temperature of water must be at 27+-2oC.

Procedure for Cube Test

- Remove the specimen from water after specified curing time and wipe out excess water from the surface.
- Take the dimension of the specimen to the nearest 0.2m
- Clean the bearing surface of the testing machine
- Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- Align the specimen centrally on the base plate of the machine.
- Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually without shock and continuously at the rate of 140 kg/cm^2/minute till the specimen fails
- Record the maximum load and note any unusual features in the type of failure.

Calculations for Concrete Cube Tests for Compressive Strength

Size of the cube =15cm x15cm x15cm

Area of the specimen (calculated from the mean size of the specimen)=225 cm^2

Characteristic compressive strength(f ck)at 7 days =

Expected maximum load =fck x area x f.s

Range to be selected is ……..

Similar calculation should be done for 28 day compressive strength

Maximum load applied =…….tones = …….N

Compressive strength = (Load in N/ Area in $mm^{2)}$=……N/mm^2

Reports of Cube Test

a) Identification mark

b) Date of test

c) Age of specimen

d) Curing conditions, including date of manufacture of specimen

f) Appearance of fractured faces of concrete and the type of fracture if they are unusual

Results of Concrete Cube Test

Average compressive strength of the concrete cube = …….N/ mm^2 (at 7 days)

Average compressive strength of the concrete cube =……. N/mm^2 (at 28 days)

Experiment No: XVII

BULKING OF SAND

Theory and Scope:

The volume of fine aggregate may increase by 1% to 5% due to presence of moisture. This property of increase in volume of fine aggregate due to moisture is called bulking.

AIM:

To find out the bulking factor of fine aggregate.

APPARATUS:

Container, Sand, Water, Mixing Pan.

Procedure:

- Take about 6 liters of dry compacted sand and weigh it and dump it into a mixing pan.
- Add a certain known percentage of water by weight of dry sand.
- Mix rapidly and thoroughly till a uniform colour is obtained and fill the container with the wet sand with out any tamping.
- Now strike off the top surface and weigh and thus find the weight of wet sand.
- Repeat the experiment No. of times increasing in water content from 1% to 20%.
- Calculations:-

W1=Wt. of 1m3 of compacted dry sand.

W2=Wt. of dry sand contained in 1m3 of wet loose sand.

W3=Wt. of 1m3 of wet sand

X = Percentage of water added

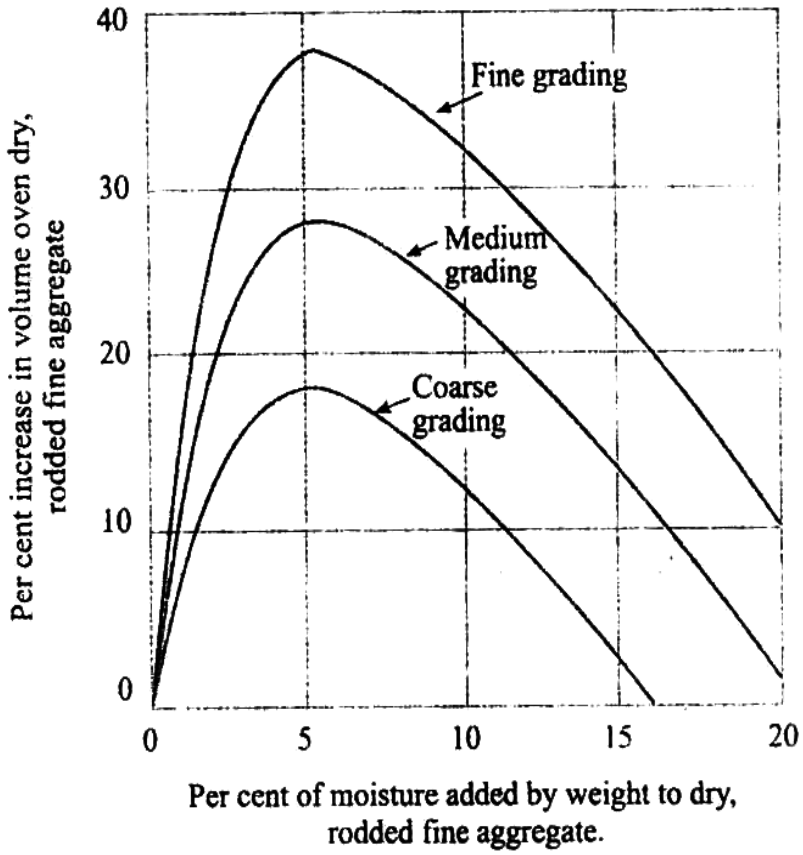
W3=Wt. of dry sand + Wt. of water

$$W3 = W2\left(1+\frac{x}{100}\right)$$

$$W2 = \frac{w_3}{1 + x/100}$$

$$\therefore \% \text{ of bulking} = \frac{W_1 - W_2}{W_1} x100$$

$$\text{Bulking factor} = \frac{W_1}{W_2}$$



RESULT:
Bulking of given Sand = ---------- % of water