LABORATORY MANUAL

011619P: Transportation Engineering-I Laboratory

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SYLLABUS

TRANSPORTATION ENGINEERING-I LABORATORY

1. To determine the aggregate crushing value of the given specimen.
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3. To determine the Specific gravity and water absorption of an aggregate sample.
4. To determine the abrasion value of coarse aggregate by using Los Angles machine.
5. To determine the penetration value of the given bitumen.
6. To determine the Softening point of the given bitumen.
7. To determine the Viscosity of the given bitumen
8. To determine the stripping value of road Aggregates.
9. To determine the Flakiness Index of given aggregates
10. To determine the Elongation Index of given aggregates

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Course objectives:

This course will enable students to

1. Basic knowledge of highway materials
2. Behavior of highway materials in different condition
3. Test on highway materials.

Course outcomes:

After a successful completion of the course, the students will be able to

1. Understand the importance of these highway materials in construction of road.
2. To perform various laboratory tests on aggregate.
3. To perform various laboratory test on bitumen.

Do’s

1. Bring observation note books, lab manuals and other necessary things for the class.
2. Use tools for mixing concrete and water
3. Check the instruments for proper working conditions while taking and returning the same.
4. Thoroughly clean your laboratory work space at the end of the laboratory session.
5. Maintain silence and clean environment in the lab

Don’ts

1. Do not operate the machines without the permission of the staff
2. Do not put hands or head while equipment is in running condition.
3. Do not fix or remove the test specimen while the main is switch on.
4. Do not spill the concrete and aggregates on the floor.

List of Experiments

EXPERIMENT NO. 1 **DATE: _________**

Determination of crushing strength of aggregate

Aim: To determine the aggregate crushing value of the given specimen.

Apparatus Used:

- Steel cylinder with open ends, and internal diameter 25.2 cm, square base plate plunger having a piston of diameter 15 cm, with a hole provided across the stem of the plunger so that a rod could be inserted for lifting or placing the plunger in the cylinder.
- Cylindrical measure having internal diameter of 11.5 cm and height 18 cm
- Steel tamping rod with one rounded end, having a diameter of 1.6 cm and length 45 cm to 60 cm.
- Balance of capacity 3 kg with accuracy up to 1 g.
- Compression testing machine capable of applying load of 40 tonnes, at a uniform rate of loading of 4 tonnes per minute

(a)

(b)

Fig.1 Aggregate crushing strength apparatus

Theory:

The Principal mechanical properties required in road stones are (i) satisfactory resistance to crushing under the roller during construction and (ii) adequate resistance to surface abrasion under traffic. Also surface stresses under rigid tyre rims of heavily loaded animal drawn vehicles are high enough to consider the crushing strength of road aggregates as an essential requirement in India.

Crushing strength of road stones may be determined either on aggregates or on cylindrical specimen cut out of rocks. These two tests are quite different in not only the approach but also in the expression of the results.

Aggregates used in road construction, should be strong enough to resist crushing under traffic wheel loads. If the aggregates are weak, the stability of pavement structure is likely to be adversely affected. The strength of coarse aggregates is assessed by aggregates crushing test. 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

Procedure:

- The aggregate passing 12.5 mm sieve and retained on 10 mm IS sieve is selected for standard test.
- The aggregate should be surface dry condition before testing.
- The aggregate may be dried by heating at a temperature 100^0C to 110^0C for a period of 4 hours and is tested after being cooled to room temperature
- The cylindrical measure is filled by the test sample of aggregate in three layers of approximately equal depth; each layer is being tamped 25 times by the rounded end of the tamping rod.
- After the third layer is tamped, the aggregate at the top of the cylindrical measure is leveled off by using the tamping rod as a straight edge. About 6.5 kg of aggregate is required for preparing two test samples. The test samples thus taken are then weighed. The same weight of the sample is taken in the repeat test.
- The cylinder of the test apparatus is placed in position on the base plate, 1/3 of the test sample is placed in the cylinder and tamped 25 times by the tamping rod. Similarly, the other two parts of the test specimen are added, each layer being subjected to 25 blows.
- The total depth of the material in the cylinder after tamping shall however be 10cm.
- The surface of the aggregates is leveled and the plunger inserted so that it rests on this surface in level position.
- The cylinder with the test sample and plunger at a uniform rate of 4 tonnes per minute until the load is 40 tonnes, and then the load is released.
- Aggregates including the crushed portion are removed from the cylinder and sieved on 2.36mm IS sieve. The material which passes this sieve is collected.

Observation Table:

Sample Number	Total wt. of dry Sample (W_1g)	Weight Of sample retained on 2.36 IS sieve (W_2 g)	Weight of fines Passing 2.36 IS sieve, (W_3 g)	Aggregate crushing value $\frac{100 W_3}{W_1}$	Average aggregate crushing value
1					
2					

Calculation:

Total weight of dry sample taken = W_1 gm.

Weight of the portion of crushed material retained on 2.36mm IS sieve = W_2 g.

Weight of the portion of crushed material passing 2.36mm IS sieve = W_3 g.

The aggregate crushing value is defined as the ratio of the weight of fines passing the specified IS sieve to the total weight of sample expressed as a percentage. The value is usually recorded up to the first decimal place.

$$\text{Aggregate crushing value} = \frac{100\,W_3}{W_1}$$

Result:

The mean of the crushing value obtained in the two tests is reported as aggregate crushing value ----------------------------------

EXPERIMENT NO. 2 **DATE: _________**

Determination of aggregate impact value

Aim: To determine the aggregate impact value of the given specimen.

Apparatus Used:

- Impact testing machine
- Cylindrical mould
- Tamping rod
- IS sieve
- Balance
- Oven

Fig.2 Aggregate impact test apparatus

Theory:

Toughness is the property of a material to resist impact. Due to traffic loads, the road stones are subjected to the pounding action or impact and there is possibility of stones breaking into smaller pieces. The road stones should therefore be tough enough to resist fracture under impact. A test designed to evaluate the toughness of stones i.e., the resistance of stones to fracture under repeated impacts may be called an impact test for road stones

Procedure:

- The test sample consists of aggregates passing 12.5 mm sieve and retained on 10 mm sieve and dried in an oven for four hours at a temperature 100^0C to110^0C and cooled.
- The aggregates are filled up to about 1/3 full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod. Further quantity of aggregates is then added up to about 2/3 full in the cylinder and 25 strokes of the tamping rod are given.
- The measure is now filled with aggregates to overflow, tamped 25 times. The surplus aggregates are struck off using the tamping rod as straight edge.
- The net weight of the aggregates in the measure is determined to the nearest gram and this weight of the aggregates is used for carrying out duplicate test on the same material.
- The impact machine is placed with its bottom plate flat on the floor so that the hammer guide columns are vertical. The cup is fixed firmly in position on the base of the machine and the whole of the test sample from the cylindrical measure is transferred to the cup and compacted by tamping with 25 strokes.
- The hammer is raised until its lower face is 38 cm above the upper surface of the aggregates in the cup, and allowed to fall freely on the aggregates.
- The test sample is subjected to a total of 15 blows, each being delivered at an interval of not less than 1 second.

- The crushed aggregate is then removed from the cup and the whole of it is sieved on the 2.36 mm sieve until no further significant amount passes. The fraction passing the sieve is weighed accurate to 0.1 g. The fraction retained on the Sieve is also weighed and if the total weight of the fractions passing and retained on the sieve is added, it should not be less than the original weight of the specimen by more than 1 gram, the result should be discarded and a fresh test made.

Observation Table:

S.No.	**Details**	**Trial number**	
		1	**2**
1	Total weight of aggregate sample filling the cylindrical measure = W_1 g		
2	Weight of aggregate retained on 2.36 mm sieve after the test = W_2 g		
3	Weight of aggregate passing 2.36 mm sieve after the test = W_3 g		
4	$W_1 – (W2 + W_3)$		
5	Aggregate Impact value = percent fines $= 100 \frac{W_3}{W_1}$ percent		
	Average		

Calculation:

The aggregate impact value is expressed as percentage of fines formed in terms of the total weight of sample.

Let the original weight of the oven dry sample be W_1 g and the weight of the fraction passing 2.36 mm IS sieve be W_3 g.

$$\text{Aggregate Impact value} = \frac{100\, W_3}{W_1}$$

Result:

Aggregate impact value of specimen --------------------------------------

EXPERIMENT NO. 3 **DATE: _________**

Determination of specific gravity and water absorption of an aggregate sample

Aim: To determine the Specific gravity and water absorption of an aggregate sample.

Apparatus Used:

- Weighing balance
- Oven
- A wire basket or perforated container of convenient size with thin wire hangers for suspending it from balance.
- A container for filling water and suspending the basket
- An air tight container of capacity similar to that of a basket
- A shallow tray and two dry absorbent cloths

(a)

(b)

Fig.3 (a) Water container (b) Wire basket

Theory:

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Stones having low specific gravity are generally weaker than those with higher specific gravity values. The specific gravity test helps in identification of stone.

Water absorption gives an idea of strength of rock. Stones having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

Procedure:

- About 2kg of the aggregate sample is washed thoroughly to remove fines, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22^0 to32^0 C and a cover of at least 5 cm of water above the top of the basket. Immediately after immersion the entrapped air is removed from the sample by lifting the basket containing it 25mm above the base of the tank and allowing it to drop 25 times at the rate of above one drop per second. The basket and the aggregate should remain completely immersed in water for a period of 24 $\pm$ ½ hour afterwards.
- The basket and the sample are then weighed while suspended in water at a temperature of 22^0 to32^0 C in case it is necessary to transfer the basket and the sample to a different tank for weighing, they should be jolted 25 times as described above in the new tank to remove air before weighing.
- The weight is noted while suspended in water = W_1 g
- The basket and the aggregate are then removed from water and allowed to drain for a few minutes, after which the aggregates are transferred to one of the dry absorbent clothes. The empty basket is then returned to the tank of water, jolted 25 times and weighed in water= W_2 g.

- The aggregates placed on the absorbent clothes are surface dried till no further moisture could be removed by this cloth. Then the aggregates are transferred to the second dry cloth spread in single layer, covered and allowed to dry for at least 10 minutes until the aggregates are completely surface dry, 10 to 60 minutes drying may be needed.
- The aggregates should not be exposed to the atmosphere, direct sunlight or any other sources of heat while surface drying. A gentle current of unheated air may be used during the first ten minutes to accelerate the drying of aggregate surface.
- The surface dried aggregates is then weighed= W_3 g
- The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110^0C for 24 hours. It is then removed from the oven, cooled in an airtight container and weighed= W_4 g

Observation Table:

Details	Test number		
	1	2	Mean value
1. Weight of saturated aggregate and basket in water= W_1 2. Weight of basket in water= W_2 3. Weight of saturated surface dry aggregate in air= W_3 4. Weight of oven dried aggregate in air = W_4 5. Specific gravity = $\frac{W_4}{W_3-(W_1-W_2)}$ 6. Water absorption = $\frac{(W_3-W_4)\times 100}{W_4}$ percent			

Calculation:

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

Weight of basket suspended in water = W_2 g

Weight of saturated aggregate in water = $(W_1 – W_2)$ = W_s g

Weight of saturated surface dry aggregate in air = W_3 g

Weight of water equal to the volume of the aggregate = $(W_3 – W_s)$ g

(1) Specific gravity = $\dfrac{\text{Dry weight of aggregate}}{\text{Weight of equal volume of water}}$

$$= \frac{W_4}{W4 - Ws} \qquad = \frac{W_4}{W_3 - (W1 - W2)}$$

(2) Water absorption = percent by weight of water absorbed in terms oven dried weight of aggregates

Result: Mean value of Specific gravity = --------------------

Mean value of Water absorption = ---------------------

EXPERIMENT NO. 4 **DATE: _________**

Determination of abrasion value of coarse aggregate

Aim: To determine the abrasion value of coarse aggregate by using Los Angles machine**.**

Apparatus used:

- Los Angles Machine (The Los Angles Abrasion Testing Machine consists of a hallow steel cylinder, closed to both ends having a inside diameter of 700 mm and inside length of 500 mm.
- Sieves
- Steel spherical ball

Fig.4 Loss angles abrasion test

Theory:

Due to the movements of traffic, the road stones used in the surfacing course are subjected to wearing action at the top. Resistance to wear or hardness is hence an essential property for road aggregates, especially when used in wearing course. Thus road stones should be hard enough to resist the abrasion due to the traffic. When fast moving traffic fitted with pneumatic tyres move on the road, the soil particles present between the wheel and road surface causes abrasion on the road stone. Steel tyres of animal drawn vehicles which rub against the stones can cause considerable abrasion of the stones on the road surface. Hence in order to test the suitability of road stones to resist the abrading action due to traffic, tests are carried out in the laboratory.

Abrasion test on aggregates are generally carried out by any one of the following methods.

(i) Los Angeles abrasion test (ii) Deval abrasion test (iii) Dorry abrasion test

Of these tests, the Los Angeles abrasion test is more commonly adopted as the test values of aggregates have been correlated with performance of studies. The ISI has suggested that wherever possible, Los Angeles abrasion test should be preferred.

In addition to the above abrasion tests, another test which is carried out to the test the extent to which the aggregates in wearing surface get polished under traffic, is '*Polished stone value*' test. Samples of aggregates are subjected to an accelerated polishing test in a machine and friction test is carried out on the polished specimen. The results of this test are useful only for comparative purpose and specifications are not yet available.

The principles of Los Angeles abrasion test is to find the percentage 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. Some investigators believe this test to be more dependable as rubbing and pounding action simulate the field conditions where both abrasion and impact occur. Los Angeles abrasion test has been standardized by the ASTM, AASHO and also by the ISI. Standard specifications of Los Angeles abrasion values are also available for various types of pavement constructions.

GRADING OF TEST SAMPLE

Sieve Size		Mass of Indicated Sizes, g			
Passing	Retained	A (12 balls)	B(11 balls)	C(8 balls)	D(6 balls)
1 ½"	1"	1250 ±25	-	-	-
1"	3/4'	1250 ±25	-	—	-
3/4"	1/2"	1250 ±10	2500 ±10	-	-
½"	3/8"	1250 ±10	2500 ±10	• —	—
3/8"	1/4"	-	-	2500 ±10	-
1/4"	#4	-	-	2500 ±10	-
#4	#8	-	-	-	5000 ±10
TOTAL		5000 ±10	5000±10	5000 ±10	5000±10

NOTE: A, B, C, and D, in the above table, represent grading of aggregate and in parenthesis the number of steel balls to be used for the particular grading.

Table.1 Grading of test sample

Procedure:

- Clean aggregates dried in an oven at 105-110^{0}C to constant weight, conforming to any one of the grading A to G as per table 1 is used for the test.
- The grading used in the test should be nearest to the grading to be used in the construction. Aggregates weighing 5 kg for grading A,B,C or D and 10 kg for grading 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 1 depending on the grading of the aggregate and is placed in the cylinder of the machine
- The cover is then fixed 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 A, B, C & D, for grading E, F & G it shall be rotated for 1,000 revolutions.
- The machine should be balanced and driven in such a way as to maintain uniform peripheral speed.
- 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 1.70 mm IS sieve, the material is first separated into two parts and the finer portion is taken out and sieved further on a 1.7 mm IS sieve

- The portion of material coarser than 1.7mm is washed and dried in an oven at 105 to 110^{0}C to constant weight and weighed correct to one gram

Observation table:

Type of aggregate grading = ---------------

Weight of charge = ---------------------------- g

Number of steel ball used = -----------------

Number of revolution = ------------------------- rpm

S.No.	Details	Test number	
		1	**2**
1	Weight of specimen = W_1 g		
2	Weight of specimen after abrasion test, coarser than 1.70 mm IS sieve = W_2 g		
3	Loss in weight due to wear = $(W_1 – W_2) = W_3$ g		
4	Percentage wear = $\frac{100\ W_3}{W_1}$		
	Average		

Calculation:

The difference between the original and final weights of the sample is expressed as a percentage of the original weight of the sample is reported as the percentage wear.

Original weight of the aggregate = W_1 g

Weight of aggregate retained on 1.70mm IS sieve after the test = W_2 g.

Loss in weight due to wear = $(W1 - W_2) = W_3$ g

$$\text{Los angles abrasion value (in \%)} = \frac{100.W3}{W1}$$

Result: Average value of Los Angeles abrasion is in ------------------------------ %

EXPERIMENT NO. 5 **DATE: _________**

Determination of penetration value of bitumen

Aim: To determine the penetration value of the given bitumen

Apparatus Used:

- Container
- Needle
- Water bath
- Penetrometer
- Stop watch

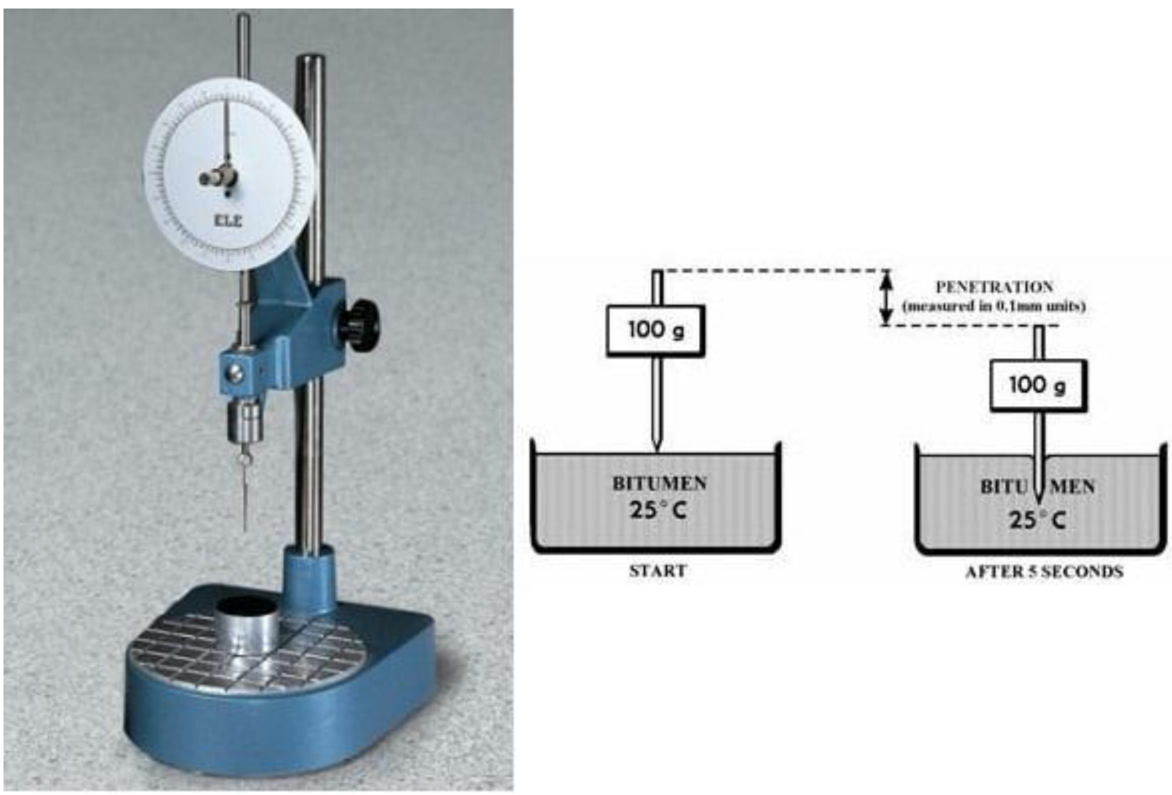

Fig.5 Penetrometer

Theory:

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 for 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 25^0 C during 5 seconds, the total weight of the needle assembly being 100g. The softer the bitumen the greater will be the penetration

Procedure:

- The bitumen is softened to a pouring consistency between 75^0 to 100^0C 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 material is then poured into the container to a depth at least 15 mm more than the expected penetration. The sample containers are cooled in atmosphere of temperature not lower than 13^0C for 1 hour. Then they are placed in a temperature controlled after bath at a temperature of 25^0 C for a period of one hour.
- The sample container is placed in the transfer tray with water from the water bath and placed under the needle of the penetrometer. The weight of needle, shaft and additional weight are checked. The total weight of the assembly should be 100g. 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 taken before releasing the needle. The needle is released exactly for a

period of 5.0 seconds by pressing the knob and the final reading is taken on the dial.

- At least three measurements are made on this sample by testing at a distance of not less than 100mm apart.
- After each test the needle is disengaged and cleaned with benzene and carefully dried. The sample container is also transferred in the water bath before next testing is done so as to maintain a constant temperature of 25^0 C.

Observation Table:

Penetrometer Dial reading	**Sample No.1**				**Sample No.2**			
	Test1	**Test2**	**Test3**	**Mean**	**Test1**	**Test2**	**Test3**	**Mean**
Initial								
Final								
Penetration value								

Result: The difference between the initial and final penetration readings is taken as the penetration value. The mean value of the three consistent penetration measurements is reported as the penetration value

The ISI has classified paving bitumen available in this country into the following six categories depending on the penetration values Grades designed ‘A’ (such as A35) are from Assam Petroleum and those designed ‘S’(such as S35) are from other sources.

Bitumen Grade	A25	A35& S35	A45& S45	A65& S65	A90& S90	A200& S200
Penetration Value	20 to 30	30to 40	40 to 50	60 to 70	80 to 100	175 to 225

Mean Penetration Value = ------------------------------ mm

EXPERIMENT NO. 6 **DATE: _________**

Determination of softening point of bitumen

Aim: To determine the Softening point of the given bitumen.

Apparatus Used:

The apparatus consists of Ring & Ball apparatus

- **Steel Balls:** They are two in number. Each has diameter of 9.5 mm and weight 2.5 $\pm$ .05 g.
- **Brass rings:** There are two rings of the following dimensions,

  Depth: 6.4 mm

  Inside diameter at top : 17.5 mm

  Inside diameter at bottom: 15.9 mm

  Outside diameter: 20.6 mm
- **Support:** The metallic support is used for placing pair of rings

Theory:

Bitumen does not suddenly change from solid state, but as the temperature increases, it gradually becomes softer until it flows readily. All semi-solid state bitumen grades need sufficient fluidity before they are used for application with the aggregate mix. For this purpose bitumen is sometimes cut back with a solvent like kerosene. The common procedure however is to liquefy the bitumen by heating.

The softening point is the temperature at which the substance attains particular degree of softening under specified conditions of the test. For bitumen, it is usually determined by Ring and Ball test.

Fig.6 Ring and ball apparatus for softening point

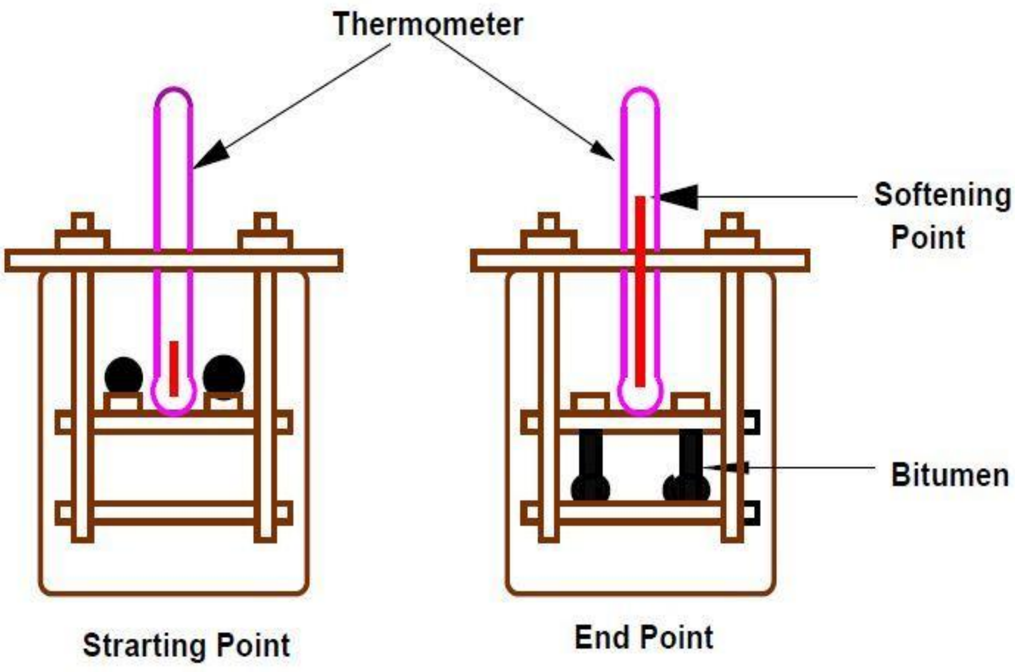

Fig.7 Softening point test

Procedure:

- Sample material is heated to a temperature between 75^0 to 100^0C above the approximate softening point until it is completely fluid and is poured in heated rings placed on metal plate.
- To avoid sticking of the bitumen to metal plate, coating is done with 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 5^0 C. This temperature is maintained for 15 minutes after which the balls are placed in position.
- The temperature of water is raised at uniform rate of 5^0 C 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 80^0C, glycerin is used as a heating medium and the starting temperature is 35^0 C instead of 5^0 C.

Observation Table:

Test Property	**Sample no. 1**		**Sample no. 2**		**Mean value, Softening point**
	Ball no.		**Ball no.**		
	(1)	**(2)**	**(1)**	**(2)**	
Temperature at which sample touches bottom plate					

Result:

The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value. The mean of the duplicate determinations is noted.

The ranges of softening point specified by ISI for various grades of bitumen are given below:

Bitumen Grades	**Softening point, ^{0}C**
A 25 & A 35	55 to 70
S 35	50 to 65
A45, S 45 & A 65	45 to 60
S 65	40 to 55
A 90 & S 90	35 to 50
A 200 & S 200	30 to 45

Softening point of bitumen = -------------------------------- ^{0}C

EXPERIMENT NO. 7 **DATE: _________**

Determination of viscosity of bitumen

Aim: To determine the Viscosity of the given bitumen

Apparatus Used:

- Orifice viscometer: Orifice viscometer consist following parts
  - Cup
  - Valve
  - Water bath
  - Sleeves
  - Stirrer

Fig.8 Viscosity apparatus

Theory:

Viscosity is defined as the inverse of fluidity. Viscosity thus defines the fluid property of bituminous material. The degree of Fluidity at the application temperature greatly influences the ability of bituminous material to spread, penetrate into the voids and also coat the aggregates and hence affects the strength characteristics of the resulting paving mixes. High or low fluidity at mixing and compaction has been observed to result in lower stability values.

Procedure:

- The tar cup is properly leveled and water in the bath is heated to the temperature specified for the test and is maintained throughout the test. Stirring is also continued. The sample material is heated at the temperature 20^0C above the specified test temperature, and the material is allowed to cool. During this the material is continuously stirred.
- When the material reaches slightly above test temperature, the same is poured in the tar cup, until the leveling peg on the valve rod is just immersed.
- In the graduated receiver (cylinder), 20 ml of mineral oil or one percent by weight solution of soft soap is poured.
- The receiver is placed under the orifice. When the sample material reaches the specified testing temperature within $\pm$ 0.1^0C and is maintained for 5 minutes, the value is opened. The stop watch is started, when cylinder records 25 ml. The time is recorded for the flow up to a mark of 75 ml.(1.e., 50 ml of test sample to flow through the orifice).

Observation:

1. Material:
2. Grade:
3. Specified test temperature, ^{0}C =
4. Size of orifice, mm =
5. Actual test temperature, ^{0}C =

Test property	Test run			Mean value
	1	**2**	**3**	
Viscosity in Seconds Repeatability, percent				

Result:

The time in seconds for 50 ml of the test sample to flow through is defined as viscosity at a given test temperature.

Therefore the temperature at which the test was conducted and the diameter of the orifice used should also be mentioned. The viscosity values of repeat tests should not vary by more than 4.0 percent from the mean value.

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EXPERIMENT NO. 8 **DATE: _________**

Determination of stripping value of road Aggregates

Aim: To determine the stripping value of road Aggregates.

Apparatus Used:

- Thermostatically controlled water bath
- Beaker
- Mixer

Theory:

The stripping value is the ratio of the uncovered area observed visually to the total area of aggregates in each test, expressed as percentage. The mean of three results is reported as stripping value of the tested aggregates and is expressed as the nearest whole number

Procedure:

This method covers the procedure for determining the stripping value of aggregates by static immersion method, when bitumen and tar binders are used. 200 g of dry clean aggregates passing 20mm IS sieve and retained on 12.5 mm sieve are heated up to 150^0C when these are to be mixed with bitumen and the aggregates are heated up to 100^0C when these are to be mixed with tar. Five percent by weight of bitumen binder is heated to 160 ^{0}C (110^0C in the case of tar binder). The aggregate and binder are mixed thoroughly till they are completely coated and mixture is transferred to a 500 ml beaker and allowed to cool at room temperature for about two hours. Distilled water is then added to immerse the coated aggregates. The beaker is covered and kept in a water-bath maintained at 40^0C taking care that the level of water in the water-bath is at east half the height of the beaker. After 24 hours the beaker is taken out, cooled at room temperature and the extent of stripping is estimated visually while the specimen is still under water.

Result:

The result is reported as the percentage of stone surface that remains coated after the specified periods, the mean value of at least three visually estimated values, being rounded off to the nearest 5 percent.

EXPERIMENT NO. 9 **DATE: _________**

Determination of Flakiness Index of given aggregates.

Aim: To determine the Flakiness Index of given aggregates.

Apparatus used:

- Standard thickness gauge
- IS sieves of sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 mm
- Weighing balance

Theory:

The Flakiness index of aggregates is the percentages by weight of particles whose least dimension (thickness) is less than three-fifths (0.6) of their mean dimension. The test is not applicable for sizes smaller than 6.3 mm

Fig.9 Flakiness index method

Procedure:

- The sample is sieved with the sieves mentioned in table-2.
- A minimum of 200 pieces of each fraction to be tested are taken and weighed = W_1gm.
- In order to separate flaky materials, each fraction is then gauged for thickness on a thickness gauge.
- The width of the slot used should be of the dimensions specified in column (3) of table-2 for the appropriate size of material.
- The amount of flaky material passing the gauge is weighed to an accuracy of at least 0.1 percent of the test sample

Table 2

Size of aggregate		Thickness gauge(0.6 times the mean sieve) (mm)
Passing through IS sieve (mm)	**Retained on IS sieve(mm)**	
63.0	50.0	33.90
50.0	40.0	27.00
40.0	25.0	19.50
31.5	25.0	16.95
25.0	20.0	13.50
20.0	16.0	10.80
16.0	12.5	8.55
12.5	10.0	6.75
10.0	6.3	4.89

Observation Table:

Size of aggregates		Weight of the fraction consisting of at least 200 pieces (gram)	Thickness gauge size (mm)	Weight of aggregates in each fraction passing thickness gauge (gram)
Passing through IS sieve (mm)	Retained on IS sieve (mm)			
63	50		23.90	
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	
10.0	6.3		4.89	
Total		**ΣW=**		**Σw=**

Calculation:

In order to calculate flakiness index of the entire sample of aggregates first the weight of each fraction of aggregate passing and retained on the specified set of sieves is noted.

Let the weight of the flaky material passing the gauge be w_1 g. Similarly the weights of the fractions passing and retained the specified sieves, W_1, W_2, W_3 etc. are weighed and the total weight $W_1 + W_2 + W_3 + \ldots = Wg$ is found. Also the weights of material passing each of the specified thickness gauges are found = w_1, w_2, w_3 ….. and the total weight of material passing the different thickness gauges= $w_1 + w_2 + w_3 + \ldots\ldots =$ w g. 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.

Flakiness index = $(w_1+w_2+w_3+\ldots\ldots\ldots) \text{ x}100/ (W_1+W_2+W_3+\ldots\ldots\ldots)$

$= \Sigma w \text{ x}100/\Sigma W$

Result: The Flakiness index of an aggregate is ------------------------------- %

EXPERIMENT NO. 10 **DATE: _________**

Determination of elongation index of an aggregate

Aim: To determine the elongation index of an aggregate sample.

Apparatus Used:

- Length gauge
- Sieves sizes
- Weighing balance

Theory:

The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. For the base course 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 possibilities of breaking down under heavy loads.

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and four fifth times (1.8 times) their mean dimension. The elongation test is not applicable to sizes smaller than 6.3 mm.

Fig.10 Length Gauge (Elongation)

Procedure:

- The sample is sieved through the IS sieves specified in table 3
- A minimum of 200 pieces of each fraction is taken and weighed.
- In order to separate elongated material, each fraction is then gauged individually for length in a length gauge.
- The gauge length used should be those specified in column 4 of 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 are collected separately to find the total weight of aggregate retained on the length gauge from each fraction.
- The total amounts of elongated material retained on the length gauge are weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

Table 3

Size of aggregate		Thickness gauge(0.6 times the mean sieve) (mm)
Passing through IS sieve (mm)	**Retained on IS sieve (mm)**	
63.0	50.0	-
50.0	40.0	81.00
40.0	25.0	58.50
31.5	25.0	-
25.0	20.0	40.50
20.0	16.0	32.40
16.0	12.5	25.60
12.5	10.0	20.20
10.0	6.3	14.70

Observation Table:

Size of aggregates		Weight of the fraction consisting of at-least 200 pieces(g)	Length gauge size, mm	Weight of aggregates in each fraction retained on length gauge, (g)
Passing through IS sieve, mm	**Retained on IS sieve, mm**			
63	50		-	-
50	40		81.0	
40	25		58.0	
31.5	25		-	-
25	20		40.50	
20	16		32.4	
16	12.5		25.5	
12.5	10.0		20.2	
10.0	6.3		14.7	
Total		**ΣW=**		**Σx=**

Calculation:

With its longest side and those elongated pieces which do not pass the gauge are separated and the total weight determined = W_1 gm.

Similarly the weight of each fraction of aggregate passing and retained on specified sieve sizes are found, W_1, W_2, W_3……. And total weight of the sample determined = $W_1 + W_2 + W_3 + \ldots\ldots = W$ gm.

Also the weight of material from each fraction retained on the specified gauge length is found = x_1, x_2, x_3….. And the total weight retained is determined = $x_1 + x_2 + x_3 + \ldots = X$ 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.

Elongation Index = $(x_1+x_2+x_3+\ldots\ldots\ldots..)\ x100\ /\ (W_1+W_2+W_3+\ldots\ldots\ldots.)$

$= \Sigma x\ .100/\Sigma W$

Result: The Elongation index of an aggregate is -------------------------------- %