Department of

Civil Engineering

LAB MANUAL

Transportation Engineering Lab

B.Tech– V Semester

KCT College OF ENGG AND TECH.
VILLAGE FATEHGARH
DISTT.SANGRUR

TRANSPORTATION ENGINEERING LABORATORY

List of Experiments

(A) Tests on aggregates

1. To determine the hardness (Abrasion) of aggregates by the Los Angles Abrasion test method.
2. To determine the toughness (impact value) of aggregates.
3. To determine the crushing value of road aggregates.
4. To determine the Specific Gravity and water absorption of aggregate.
5. To determine the flakiness and elongation indices of the given aggregate sample.

(B) Tests on bitumen

6. To determine the softening point of bitumen.
7. To determine the Ductility of bituminous material.
8. To determine the flash and fire point of given bitumen sample.
9. To determine the viscosity of tar/emulsion by viscometer test (indirect test) .
10. To determine the Penetration test of Bitumen.
11. To determine the Specific Gravity of Bitumen.

(C) Tests for Bituminous Mix Design

12. To determine the OBC using Marshall Mixed Design Method.
13. To determine the Bitumen content of core sample by centrifugal extractor.

EXPERIMENT NO-1

LOS ANGELES ABRASION TEST

1. Objective:

To determine the hardness (Abrasion) of aggregates by the Los Angeles Abrasion test method

2. Apparatus/Equipments Required:

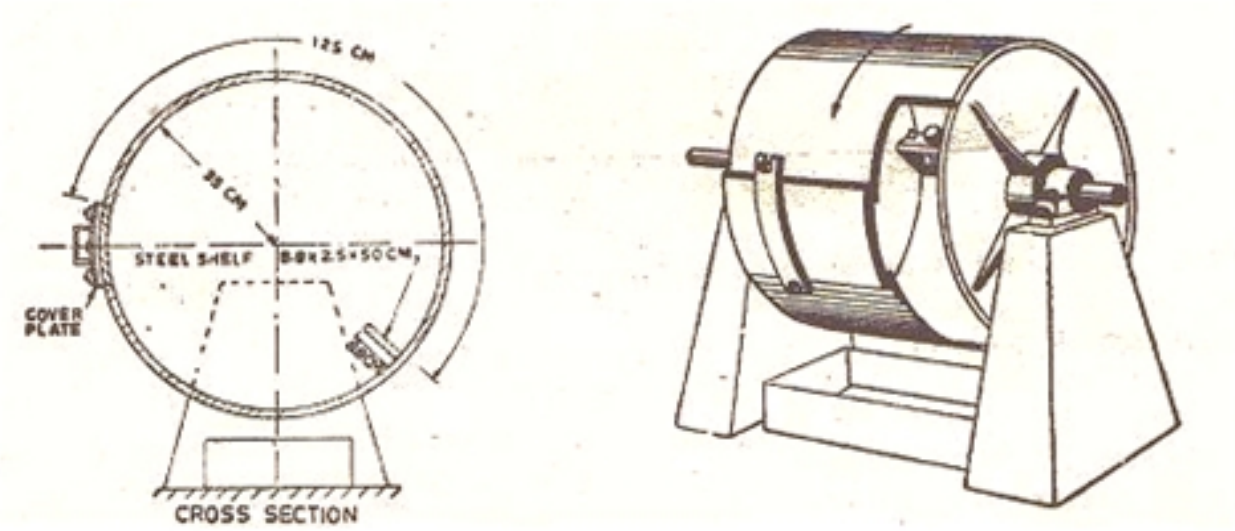
1. It consists of a hollow cylindrical machine closed at both ends having 70 cm internal diameter and 50 cm long, mounted on supports so that it may rotate about its horizontal axis.
2. Steel spherical balls 4.5 cm diameter and weighing 390grams to 445 grams. The weight and number of balls per charge of aggregate depends upon the grading of aggregate sample.
3. Sieve of size 1.7 and balance of capacity 10 kg.

3. 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.

4. Procedure:

1. Aggregate sample weighing 5 kg or 10 kg depending on the grading is put in the machine along with the abrasive charge.
2. The machine is rotated at a speed of 30 to 33 r.p.m for the specified number of revolutions (500 to 1000) depending on the grading of aggregate.
3. Now the sample is taken out of the machine and sieved through 1.7 mm I.S. Sieve and the weight of aggregate passing through 1.7 mm sieve is determined.



Los Angeles Abrasion Testing Machine

5. Observation:

1. Type of aggregate =
2. Grading =
3. Number of spheres used =
4. Weight of charge =
5. Number of revolution =

Observations	**Sample 1**	**Sample 2**
Weight of aggregate, W_1 g =		
Weight of aggregate retained on 1.7 mm IS sieve after the test , W_2 g =		
Loss in weight due to wear = W_1 - W_2 g		
Percentage wear = $\frac{(W_1 - W_2)}{W_1} \times 100$		
Los Angeles Abrasion , Average Value =		

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	12.5-10	10-6.3	6.3-4.75	4.75-2.36	No. of Spheres	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	-	-	-	-	-	-	-	-	-	5000	6	2500± 15
E	2500	2500	5000	-	-	-	-	-	-	-	12	5000± 25
F	-	-	5000	5000	-	-	-	-	-	-	12	5000± 25
G	-	-	-	5000	5000	-	-	-	-	-	12	5000± 25

Table Maximum allowable Los Angeles abrasion values of aggregates in different types of pavement layers

Sl. No.	Types of pavement layer	Los Angeles abrasion value, maximum %
1	(i) WBM Sub-base, WBM, WMM and CRM base course (ii) Bituminous Macadam base / binder course (iii) Bituminous Penetration Macadam, Built-up spray grout base course	40
2	(i) Dense graded Bituminous Macadam binder course (ii) Cement Concrete Pavement	35
3	(i) Bituminous carpet surface course (ii) Bituminous surface dressing, single or two coats (iii) Close graded Bituminous Surfacing / Mixed Seal Surfacing	40
4	Bituminous concrete surface course	30

6. Calculation

Los Angles abrasion value, % = Percentage wear = $\frac{(W_1 - W_2)}{W_1} \times 100$

7. Result

For test sample = ……

Standard value = …….

%age error =…….

8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-2

AGGREGATE IMPACT VALUE TEST

1. Objective:

To determine the toughness (impact value) of aggregates.

2. Apparatus/Equipments Required:

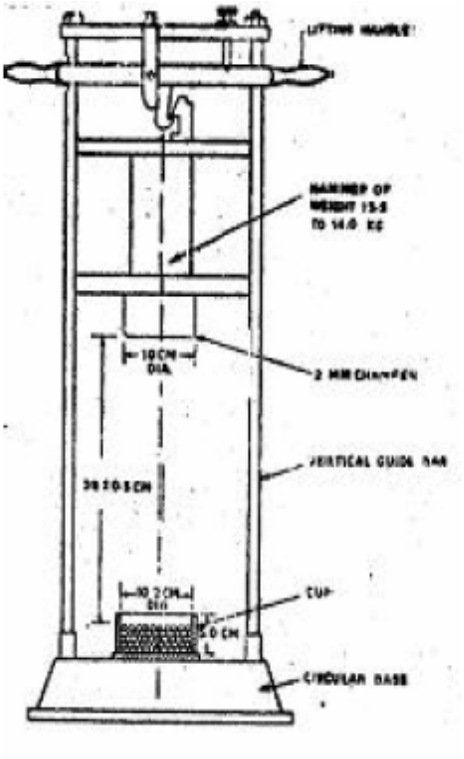
1. Impact testing machine
2. Cylindrical measure
3. Tamping rod
4. Sieve 12.5, 10, and 2.36 mm.
5. Balance
6. Oven (thermostatically)

3. 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.

4. Procedure:

1. Dry aggregate specimen passing 12.5 mm sieve and retained on 10 mm sieve is filled in three equal layers by 25 blows with the help of tamping rod and weighed. Let the weight of sample be W_1 Kg.
2. The sample is now transferred to the cup of the impact test apparatus and compacted by tamping rod 25 times.
3. Now the hammer is raised to a height of 38 cm above the surface of the aggregate in the cup and is allowed to fall freely in the specimen. In this 15 blows are given to the aggregate specimen.
4. Now the aggregate sample is sieved through 2.36 mm I.S. Sieve and the fraction passing through this sieve is weighed. Let the weight of this fraction be W_2 Kg.



Aggregate Impact Testing Machine

5. Observation:

Table Results of aggregate impact test

Serial No.	Details	Trial Number		Average
		1	2	
1	Total weight of aggregate sample filling the cylindrical measure = W_1 g			
2	Weight of aggregate passing 2.36 mm sieve after the test = W_2 g			
3	Weight of aggregate retained on 2.36 mm sieve After the test = W_3 g			
4	Difference in weight = $W_1 - (W_2 + W_3)$ g			
5	Aggregate Impact value = percent fines = $\frac{100 W_2}{W_1}$ %			

AGGREGATE IMPACT TEST

Aggregate Impact Value, %	Toughness property
Less than 10	Exceptionally tough / strong
10 to 20	Very tough / strong
20 to 30	Good for pavement surface course
Above 35	Weak for pavement surface

Table Maximum allowable aggregate impact value of aggregate in different types of pavement material / layers as per IRC

Sl. No.	Types of pavement material / layer	Aggregate impact value, maximum, %
1	Sub-base course and Water bound macadam (WBM) layer	50
2	(i) WBM base course with bitumen surfacing (ii) Built up-spray grout, base course	40
3	Wet Mix Macadam (WMM) base course and WBM surface course	30
4	Binder and surface courses of pavements (i) Dense Bituminous Macadam binder courses (ii) Bituminous Surface Dressing, Carpet and Bituminous Concrete surface (iii) Cement Concrete surface course	30

6. Calculation

Aggregate impact value = percent fines = $\frac{W_2}{W_1} \times 100$

(i) For sample 1 ……..

(ii) For sample 2 ……..

7. Result

For test sample = …….

Standard value = …….

%age error =…….

8. Precautions:

9. Remarks:

10. Discussion

EXPERIMENT NO-3

AGGREGATE CRUSHING VALUE TEST

1. Objective:

To determine the crushing value of road aggregates.

2. Apparatus/Equipments Required:

1. Steel cylinder of 15.2 cm internal diameter with base plate and plunger. The height of the cylinder may vary from 13 to 14 cm. The thickness of cylinder walls may be 1.6 cm.
2. Cylindrical measure of internal diameter 11.5 cm. and height18 cm.
3. Steel tamping rod 45 to 60 cm. long and 1.6 cm diameter having a pointed end.
4. Compression testing machine capable of applying load of 40 tones, at a uniform rate of loading of 4 tons per minute.
5. Balance of cap. 3 kg with accuracy up to 1 g
6. Sieves of 12.5 mm, 10 mm and 2.36 mm.

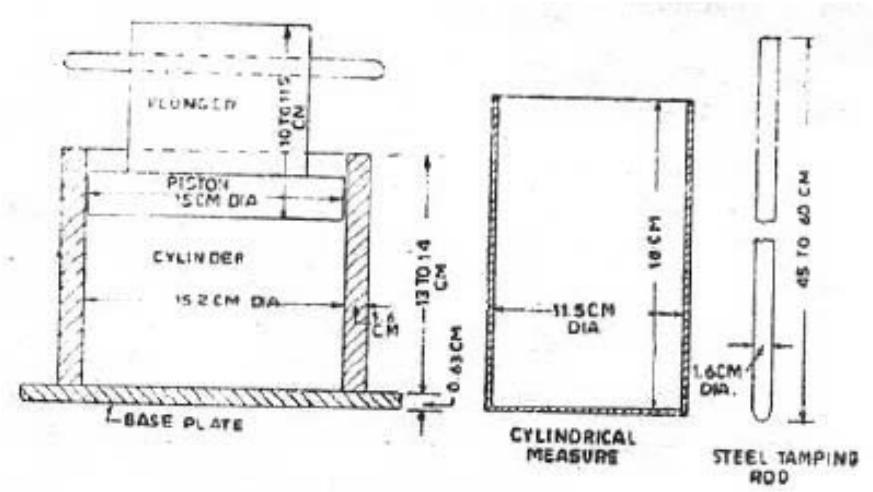
3. Theory:

The principal mechanical properties required inroad 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 and drawn vehicle are high enough to consider the crushing strength of road aggregates as essential requirements in India.

4. Procedure:

1. Aggregate passing 12.5 mm I.S. sieve and retained on 10 mm sieve is taken and dried. This aggregate filled in the cylindrical measure in three equal layers and each layer tamped 25 times by the tamping rod.
2. Now the test sample is weighed and filled in the test cylinder in three equal layers and tamped each layer 25 times. Let the weight of aggregate be W_1 Kg.
3. Now the plunger is placed on the top of the test specimen and whole apparatus is put in the compression testing machine.
4. Now the specimen is loaded to a total load of 40 tonnes at the rate of 4 tonnes per minute i.e., the total load s reached in 10 minutes in the compression machine.

5. Now the test cylinder is removed from the compression machine and aggregate sieved through 2.36 mm sieve. The material passed through the 2.36 mm sieve is weighed. Let the weight be W_2 Kg.



Aggregate Crushing Test Apparatus

5. Observation:

Serial No.	Details	Trial No.	
		1	2
1.	Total weight of aggregate sample filling the cylindrical measure , W_1 g		
2.	Weight of aggregate passing 2.36 mm sieve after the test , W_2 g		
3.	Weight of aggregate retained on 2.36 mm sieve after the test = W_3 g		

6. Calculation

$$\text{Aggregate crushing value = percent fines} = \frac{W_2}{W_1} \times 100$$

(i) For sample 1 ……..

(ii) For sample 2 ……..

7. Result:

For test sample = ……

Standard value = …….

%age error =…….

8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-4

SPECIFIC GRAVITY AND WATER ABSORPTION TEST

1. Objective:

To determine the specific gravity and water absorption of aggregates by perforated basket.

2. Apparatus/Equipments Required:

1. A wire basket of not more than 6.3mm mesh or a perforated container of convenient size with thin wire hangers for suspending it from the balance.
2. A thermostatically controlled oven to maintain temperature of 100^0 to 110^0 C.
3. A container for filling water and suspending the basket.
4. An airtight container of capacity similar to that of the basket.
5. A balance of capacity about 5 kg. to weight accurate to 0.5 g, and of such a type and shape as to permit weighing of the sample container when suspended in water.
6. A shallow tray and two dry absorbent clothes, each not less than 750 X 450 mm.

3. Theory:

The specific gravity of an aggregate is considered to a baa measure of strength or quality of the material . The specific gravity test helps in the identification of stone.

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

4. Procedure:

About 2 kg 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 to 32^0 with a cover of at least 50mm 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 about one drop per second. The basket and the aggregate should remain completely immersed in water for a period of 24 +/- 0.5 hours afterwards.

The basket and the sample are then weighed while suspended in water at a temperature of 22^0 to 32^0 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. This weight is noted while suspended in water W1 g. The basket and the aggregate are then removed from water and allowed to drain for a few minutes, after which 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 ten returned to the tank of water, jolted 25 times and weight in water W2 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 a 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 source 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 aggregate is then weighed W3 g. The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110^0 C for 24 hours. It is then removed from the oven, cooled in an airtight container and weighed W4 g. At least two tests should be carried out, but not concurrently.

5. Observation and Calculation

Weight of saturated aggregate suspended in water with the basket = W1 g
Weight of basket suspended in water = W2 g
Weight of saturated aggregate in water = (W1-W2) = Ws g
Weight of Saturated surface dry aggregates in air = W3 g
Weight of oven dry aggregate in air = W4 g
Weight of water equal to the volume of the aggregate = (W3-Ws) g

(i) Specific Gravity =

$$\frac{\text{Dry Weight of aggregate}}{\text{Weight of equal volume of water}}$$

$$= \frac{W_4}{W3 - Ws} = \frac{W_4}{W3 - (W1 - W2)}$$

(ii) Apparent Specific Gravity =

$$\frac{\text{Dry Weight of aggregate}}{\text{Weight of equal volume of water excluding air voids in aggregates}}$$

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

(iii) Water absorption = Percent by Weight of water absorbed in terms oven dried weight of aggregates.

$$= \frac{(W3 - W_4) \times 10_0}{W_4}$$

Limits: The specific gravity of aggregates ranges from 2.5 to 3.0

The water absorption of aggregates ranges from 0.1 to 2.0 %

S. No.	DESCRIPTION	TEST NUMBER			MEAN VALUE
		1	2	3	
1	Weight of saturated aggregate suspended in water with the basket = W1 (gms)				
2	Weight of basket suspended in water = W2 (gms)				
3	Weight of Saturated surface dry aggregates in air = W3 (gms)				
4	Weight of oven dry aggregate in air = W4 (gms)				
5	Specific Gravity = W4/(W3-(W1-W2))				
6	Apparent Specific Gravity = W4/(W4-(W1-W2))				
7	Water absorption = ((W3-W4)×100)/W4				

7. Result:

Specific Gravity = ……

Apparent Specific Gravity = …….

Water absorption =…….

EXPERIMENT NO-5

FLAKINESS AND ELONGATION INDICES TEST

1. Objective:

To determine the flakiness and elongation indices of the given aggregates sample

2. Introduction:

The particle shape of aggregates is determined by the percentages of flaky and elongated particle contained in it. In the case of gravel it is determined by its angularity number. For 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. Rounded aggregates are preferred in cement concrete road construction as the work ability concrete improves. Angular shapes of particles are desirable for granular base course due to increase stability divided from the better interlocking. When the shape of aggregates deviates more from the spherical shape, as in the case of angular, flaky and elongated aggregate, the void content in aggregate of any specified size increases and hence the grain size distribution of a graded aggregate has to be suitable altered in order to obtain minimum voids in the dry mix of the highest dry density. The angularity number denotes the void content of single sized aggregates in excess of that obtained with spherical aggregates of the same size. Thus angularity number has considerable importance in the gradation requirements of various types of mixes such as bituminous concrete and soil-aggregate mixes.

The evaluation of shape of the particles, particularly with reference to flakiness, elongation an angularity is necessary.

3. Test for Determinations of Flakiness Index

Apparatus: -

The apparatus consists of

1. A standard thickness gauge,
2. IS sieves of sizes 63, 50, 40, 31.5,25, 20, 16, 12.5, 10 and 6.3 mm and
3. A balance to weigh the samples.

Theory: - The flakiness index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three-fifths (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3 mm.

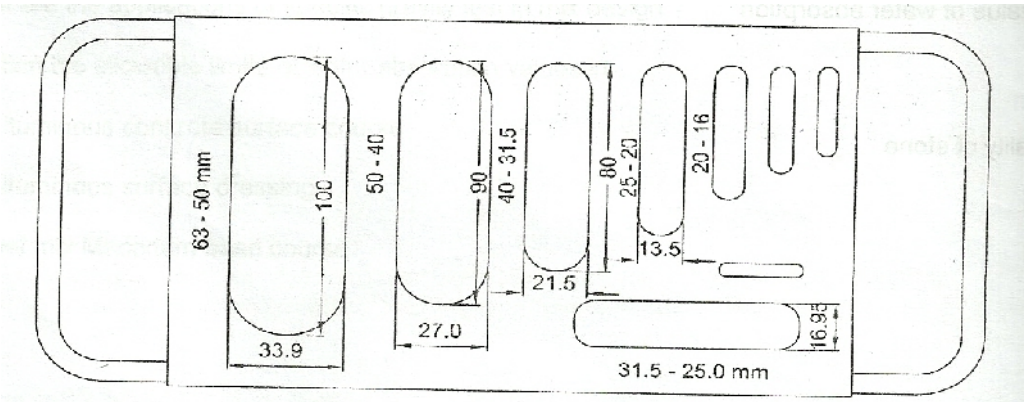


Fig. Thickness Gauge

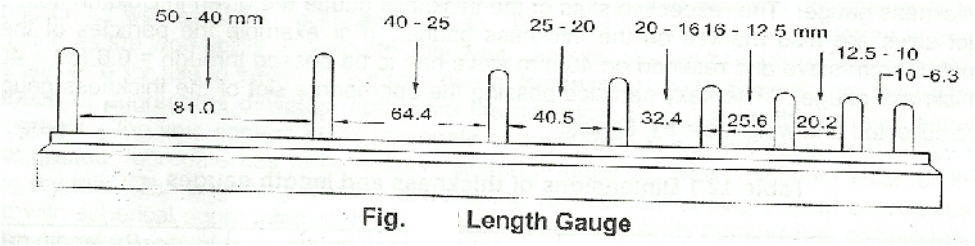


Fig. Length Gauge

Procedure: -

This test is conducted by using a metal thickness gauge.

1. A sufficient quantity of aggregate is taken such that a minimum number of 200 pieces of any fraction can be tested.
2. Each fraction is gauged in turn for thickness on the meal gauge.
3. The total amount passing in the gauge is weighed to an accuracy of 0.1per cent of the weight of the samples taken.
4. The flakiness index is taken as the total weight of the material passing the various thickness gauges expressed as a percentage of the total weight of the sample taken. Table 1 shows the standard dimensions of thickness and Length gauges.

Table 1 Shows Thickness and length gauges
(IS: 2386 (Part 1) -1963)

Size of Aggregate		Thickness gauge (0.6 times the mean sieve) mm	Length gauge (1.8 times the mean sieve),mm
Passing Through IS sieve mm	Retained on IS sieve mm		
63.0 mm	50mm	33.9	-
50.0 mm	40 mm	0	81.0
40.0 mm	25 mm	27.0	58.5
31.5 mm	25 mm	0	-
25.0 mm	20 mm	19.5	40.5
20.0 mm	16mm	0	32.4
16.0 mm	12.5mm	16.9	25.6
12.5 mm	10.0 mm	5	20.2
10.0 mm	6.3 mm	13.5	14.7
		0	
		10.8	
		0	
		8.55	
		6.75	
		4.89	

Table ... Maximum allowable flakiness index of aggregates in different types of pavement construction as per IRC

S.No.	Types of pavement construction	Maximum limits of flakiness Index, %
1	Bituminous carpet	30
2	(i) Bituminous Concrete	25
	(ii) Bituminous penetration macadam	
	(iii) Bituminous surface dressing (single coat, two coats and pre-coated)	
	(iv) Built-up spray grout	
3	(i) Bituminous macadam	15
	(ii) Water bound macadam, base and surfacing courses	

4. Test for Determination of Elongation Index

Apparatus

The apparatus consists of the length gauge, sieves of the sizes specified in table and a balance.

Theory:

The elongation index on an aggregate is the percentage by weight of particles whose greatest dimension (Length) is greater than 1.8 times their mean dimension .The elongation index is not applicable to sizes smaller than 6.3 mm

Procedure:

This test is conducted by using metal length gauge of the description. A sufficient quantity of aggregate is taken to provide minimum number of 200 piece of any fraction to be tested. Each fraction shall be gauged individually for length on the metal gauge. The gauge length used shall be that specified in column of table 3.18 for the appropriate size of material. The total amount retained by the gauge length shall be weighed to an accuracy of at least 0.1 per cent of the weight o the test samples taken. The elongation index s the total eight of the material retained on the various length gauges expressed as a percentage of the total weight of the sample gauged. The presence of elongated particles in excess of 10 to 15 per cent is generally considered undesirable, but no recognized limits are laid down. Indian standard explain only the method of calculating both flakiness index and elongation index. But the specifications do not specify the limits .British standard BS 882 of 1992 limits the flakiness index of the coarse aggregate to 50 for natural gravel and to 40 for rushed coarse aggregate. However, for wearing surfaces lower values of flakiness index are required.

4. Observation sheet

Flakiness index and Elongation index

Size of aggregate		Weight of the fraction consisting of at least 200 pieces, **gm**	Thickness gauge size **mm**	Weight of aggregates in each fraction passing thickness gauge, **gm**	Length gauge size, **mm**	Weight of aggregates in each fraction retained on length gauge, **gm**
Passing through is sieve, **mm**	Retained on IS sieve, **mm**					
1	**2**	**3**	**4**	**5**	**6**	**7**
63	50	W1 =	23.90	w1 =	--	--
50	40	W2 =	27.00	w2 =	81.0	x1 =
40	31.5	W3 =	19.50	w3 =	58.0	x2 =
31.5	25	W4 =	16.95	w4 =	--	--
25	20	W5 =	13.50	w5 =	40.5	x3 =
20	16	W6 =	10.80	w6 =	32.4	x4 =
16	12.5	W7 =	8.55	w7 =	25.5	x5 =
12.5	10.0	W8 =	6.75	w8 =	20.3	x6 =
10.0	6.3	W9 =	4.89	w9 =	14.7	x7 =
Total		W =		w =		x =

6. Calculations:

Flakiness index = $\frac{(w_1 + w_2 + w_3 + ...)}{(W_1 + W_2 + W_3 + ...)} 100\, percent = \frac{100w}{W}\, percent$

Elongation index = $\frac{(x_{1_1} + x_2 + x_3 + ...)}{(W_1 + W_2 + W_3 + ...)} 100\, percent = \frac{100x}{W}\, percent$

7. Result:

For test sample = 1…… 2. ……

Standard value = 1 …… 2. ……

%age error = 1 … ……2. ……

8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-6

SOFTENING POINT TEST

1. Objective:

To determine the softening point of bitumen.

2. Apparatus/Equipments required:

1. A brass ring and steel ball.
2. Water bath and stirrer.
3. Thermometer.
4. Metallic support

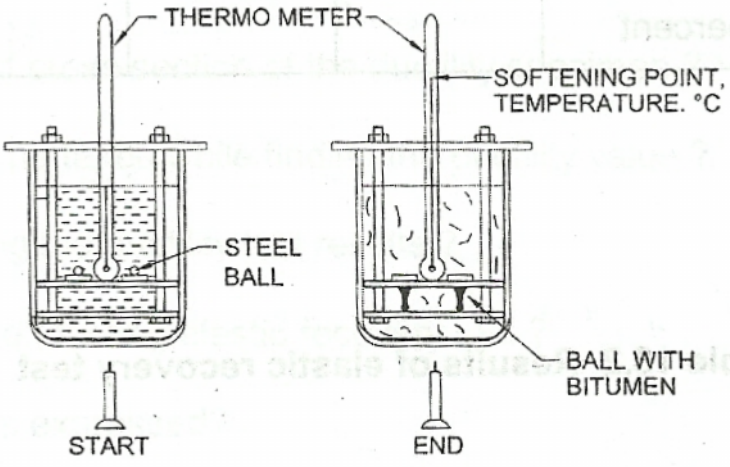


Fig. Softening Point Test Concept

3. Theory:

Softening point is defined as the temperature at which a substance attains a particular degree of softening under specified conditions of test. Usually softening point for different grades of bitumen used for pavements vary from 35°C to 70°C.

4. Procedure:

1. Sample material is heated to a temperature between 75 and 100°C above the approximate softening point until it is completely fluid.

2. The bitumen test sample is placed in the brass ring and the ring is suspended in water at a given temperature.
3. A steel ball is put on the bitumen and the water bath is heated such that the temperature of water bath rises by 5°C per minute.
4. The temperature at which the softened bitumen touches the metal plate placed at a specified distance below the ring is noted. This temperature is called the softening point of the bitumen. Higher the softening point, harder the grade of the bitumen.

5. Observation:

1. Bitumen grade: ……
2. Approximate softening point: ……...
3. Liquid used in the bath: ……..
4. Period of air cooling, minutes: …….
5. Period of cooling in water bath, minutes = …….

Rate of heating:

Time (minutes)	Temperature (°C)	Time (minutes)	Temperature (°C)
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

Observation:

Test property	Sample No. 1		Sample No. 2		Mean value softening point
	Ball No,		Ball No.		
	(i)	(ii)	(i)	(ii)	
Temperature(°C) at which sample touches bottom plate					
Repeatability					
Oducibility					

6. Calculations:

7. Results

For test sample = ……

Standard value = …….

%age error =…….

EXPERIMENT NO-7

DUCTILITY TEST

1. Objective:

To determine the Ductility of bituminous material.

2. Theory:

Ductility is a measure of elasticity of adhesiveness of bitumen. It is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks. As per I.S. 1208-1958, the test should be conducted at 27° C and the pull should be applied at the rate of 50 mm per minute. The minimum width of cross-section should be 10×10 mm.

3. Apparatus /Equipments required:

1. Briquette of standard dimensions.
2. Pulling device with distance measuring dial.
3. Water bath arrangement.
4. Knife.
5. Heating mental.
6. Thermometer.
7. Glycerin.

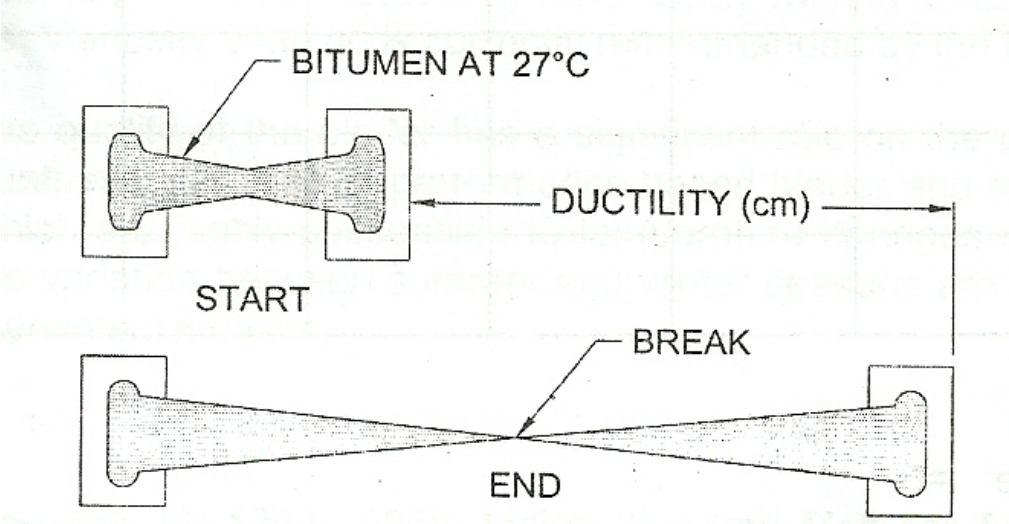


Fig. Ductility test concept

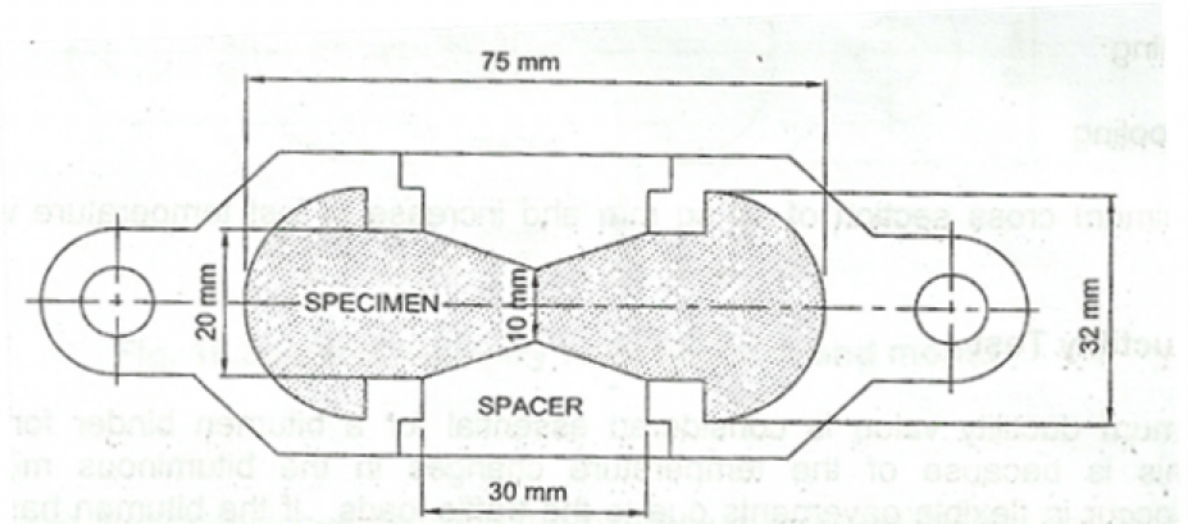


Fig. Ductility Test Specimen and Mould

4. Procedure:

1. The bitumen sample is heated to bring it in fluid state and poured in the briquette assembly and placed on a brass plate.
2. The whole assembly including bitumen briquette along with brass plate is allowed to cool in air.
3. The excess bitumen is cut and surface is leveled with the help of a hot knife.
4. The whole assembly now is kept in a water bath maintained at 27°C for about 85 to 95 minutes.
5. The side of the mould removed, the clips hooked on the machine and the pointer adjusted to zero value or initial reading noted.
6. Now the clips are pulled apart horizontally at the rate of 50 mm per min. and the distance up to the point of breaking of thread is noted. This distance in centimeter gives the value of ductility of bitumen.
7. The ductility of bitumen may vary from 5 to 100 for different bitumen grades, but for satisfactory performance it should not be less than 50.
8. Ductility of bitumen is influenced by pouring temperature, dimensions of briquette, test temperature, rate of pulling, etc.

5. Observation:

1. Weight of sample (same for all samples) = …….
2. Test temperature (same for all samples) = …….
3. Grade of bitumen (same for all samples) =……..
4. Ductility in cm.

Sample No.	Ductility in cm
1	
2	
3	
4	
5	

6. Calculation:

Average ductility in cm. = ……..

7. Result:

Ductility value

For test sample

Average ductility = ……..cm.

Standard value = ……..cm

%age error = ……..%

Repeatability	10 % of mean
Reproducibility	20 % of mean

8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-8

FLASH AND FIRE POINT TEST

1. Objective:

To determine the flash and fire point of given bitumen sample.

2. Apparatus/Equipments required:

1. Pensky-Martens closed tester consists of cup, lid, stirring device, cover, shutter, flame, exposure device etc.
2. Pensky-Martens open tester as above with the modification, that the cover of the cup is replaced by a clip which encircles the upper rim of the cup and carries thermometer and test flame.

3. Theory:

1. **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 condition of test''.
2. **Fire point: -** ''The fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test''.

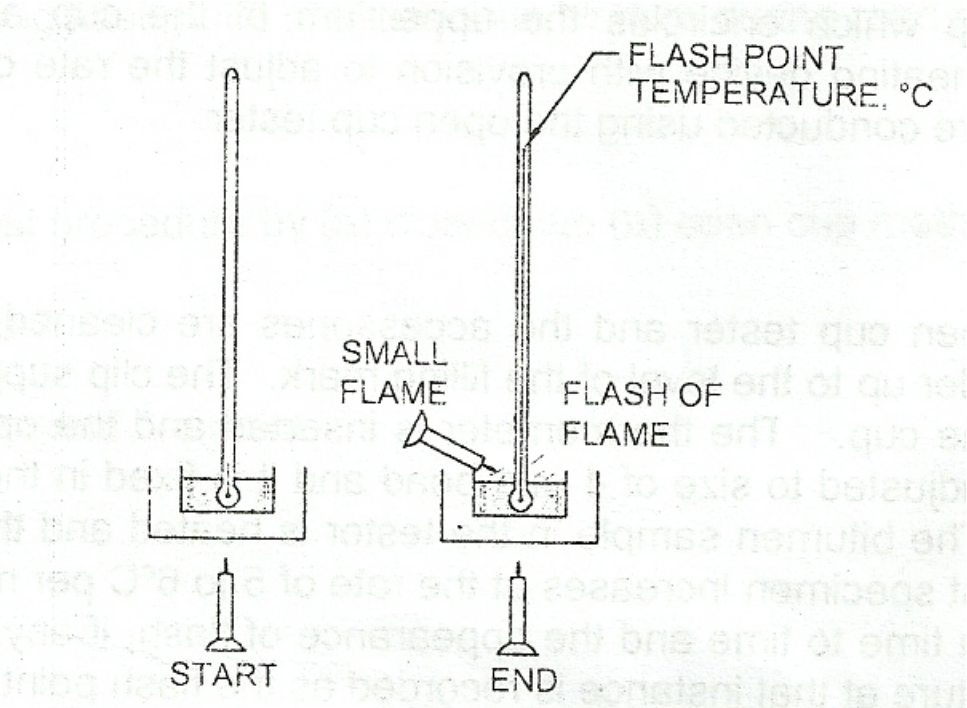


Fig. Flash point test concept

4. Procedure:

1. All parts of the cup are cleaned and dried thoroughly before the test is started.
2. The material to be tested is filled in the cup up to a definite mark called filling mark and the lid is placed to close the cup in closed cup apparatus.
3. Thermometer of specified range and other accessories are suitably fixed.
4. The bitumen specimen is heated at the rate of 5 C per minute and stirred well during the heating period.
5. The test flame is brought near the heated specimen at intervals depending upon the expected flash and fire points. First application of flame is made at least 17C below the flash point, then at every 1C - 3C rise in temperature.
6. The temperature at which the application of flame causes a bright flash inside the cup in the closed cup system is taken as the flash point.
7. For open cup system, the instance when flash appears first at any point on the surface of the material is called flash point.
8. On further heating, the temperature at which the material gets ignited and continuously burn for 5 seconds, is called the fire point. The minimum specified flash point for bitumen in closed cup type system is 175°C.

5. Observation

1. Bitumen grade /cutback type and grade: ……
2. Type of equipment: Closed cup/Open cup: ……

Rate of heating

Time in minutes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Temperature,°C												

Test property	**Test Number**			**Mean value**
	1	**2**	**3**	
1. Flash point 2. Fire point 3. Variations from mean value				

6. Calculations:

7. Results

For test sample = ……

Standard value = ……

%age error =……

8. Precautions:

9. Remarks:

10. Discussion:

Flash Point	Repeatability	Reproducibility
104°C and below	2°C	3.5°C
Above 104°C	5.5°C	8.5°C

Test	Repeatability	Reproducibility
Flash point	8°C	11°C
Fire point	8°C	14°C

EXPERIMENT NO-9

VISCOSITY TESTS

PART A

1. Objective:

To determine the viscosity of tar/emulsion.

2. Apparatus/Equipments Required:

Ten millimeter orifice viscometer is specified for testing road tar and is called tar viscometer, 4.0 mm orifice is used to test cutback grades, 0 and 1 and 10 mm orifice to test all other grades. The apparatus consists of main part like cup, valve, water bath, sleeves, stirrer, receiver and thermometers, etc.

3. Theory:

Viscosity is the measure of resistance to flow. It is measured by recording the time in seconds taken by 50 c.c. of the material to flow through a specified orifice of standard dimension into a receiver at specified temperature.

4. 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°C above the specified test temperature, and the material is allowed to cool.
- During this the material is continuously, stirred.
- When material reaches slightly above test temperature, the same is poured in 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 ± 0.1°C and is maintained for 5 minutes, the valve is opened.
- The stop watch is started, when cylinder records 25ml.
- The time is recorded for flow up to a mark of 75ml. (i.e., 50ml of test sample to flow through the orifice).

The viscosity test on road tar is carried out using 10 mm orifice and the standard test temperature for road tar grades RT_1, RT_2, RT_3, and RT_4 are 35, 40, 45, and 55°C respectively. In case the viscosity test is being carried out to classify a given sample of road tar of to find its grade, then the test should be first conducted at the lowest temperature of testing road tar, i.e. 35°C; if the time taken for 50ml of the tar sample to flow through the 10 mm orifice is

more than 55 sec, of if the sample does not flow freely test may be repeated at the next higher temperature, till the viscosity value falls in the specified range.

The viscosity test on cutback bitumen is carried out using 4.0 mm orifice for grades 0 and 1 (SC – 0, MC – 0, RC – 0, SC – 1, MC – 1, RC – 1, at 25°C). The test for cutback grades 2 and 3 are carried out at 25°C using 10 mm orifice and those for grades 4 and 5 are carried out at 40°C using 10 mm orifice. For details of requirements of cutbacks see Tables 23.1 – a, b & c. if the viscosity of an unknown grade of cutbacks, is to be determined, the orifice size and the trial test temperature may be chosen using judgment. If the viscosity value of the trial test does not fall within the specified range, test should be repeated by altering the test temperature or orifice size or both suitably.

5. Observation:

1. Material: …….
2. Grade: …….
3. Specified temperature, °C = ……
4. Size of orifice, mm = …….
5. Actual test temperature, °C ……

Test Property	Test run			Mean value
	1	2	3	
Viscosity in seconds				
Repeatability, percent				

6. Calculations:

7. Results

For test sample = ……

Standard value = …….

%age error =…….

8. Precautions:

9. Remarks:

10. Discussion:

PART A

Table Viscosity grading of bitumen and consistency properties

S.No.	Viscosity grading	Absolute viscosity at 60 °C, Poise (min.)	Kinematic viscosity at 135 °C, cSt (min.)	Range of penetration value at 25 °C
1	VG 10	800	250	80 – 100
2	VG 20	1600	300	60 – 80
3	VG 30	2400	350	50 – 70
4	VG 40	3200	400	40 – 60

EXPERIMENT NO-10

PENETRATION TEST

1. Objective:

Penetration test on Bitumen.

2. Apparatus/Equipments required:

1. Container
2. Needle
3. Water bath
4. Penetrometer
5. Transfer tray

3. Theory:

This test is applied almost exclusively on bitumen. For tars, cutback and emulsions other consistency tests are used. This test determines the hardness or softness of bitumen by measuring the depth in millimeter to which a standard loaded needle will penetrate vertically in 5 seconds while the temperature of the bitumen sample is maintained at 25°C.

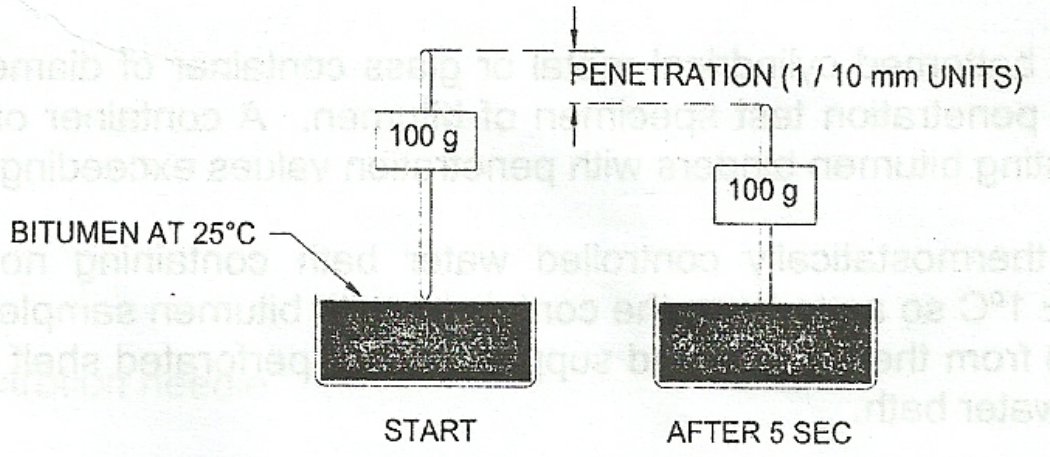


Fig. Penetration test concept

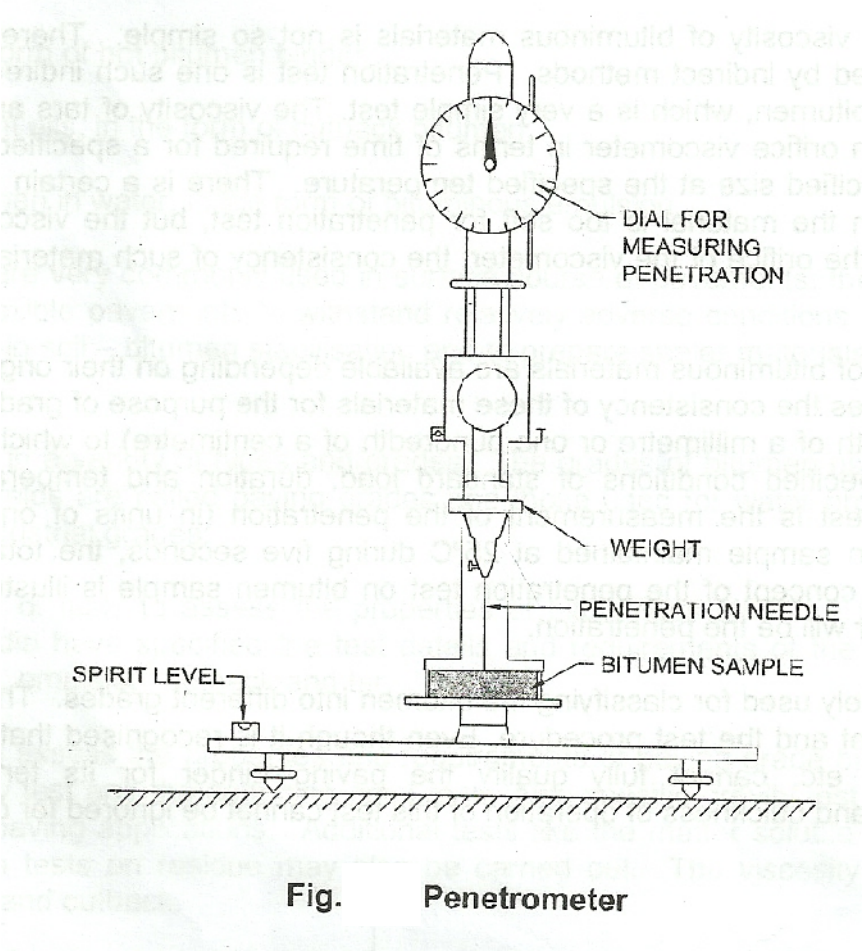


Fig. Penetrometer

4. Procedure:

1. The bitumen is softening to a pouring consistency, stirred well and poured into the test containers. The depth of bitumen in containers is kept at least 15 mm more than the excepted penetration.
2. The sample now the sample containers are placed in a temperature controlled water bath at a temperature of 25°C for one hour.
3. At the end of one hour, the sample is taken out of water bath and needle is brought in contact with the surface of bitumen sample and the reading of dial is set at zero or the reading of dial noted, when the needle is in contact with the surface of the sample.
4. Now the needle is released and the needle is allowed to penetrate for 5 seconds and the final reading is recorded on the same sample at least three penetration observations should be taken at distances at least 10 mm apart. After each test, the sample needle is disengaged, wiped wit benzene and dried.
5. The mean value of three measurements is reported as penetration test.
6. The accuracy of the test depends upon pouring temperature, size of needle, weight placed on needle, and test temperature.
7. The grade of bitumen is specified in terms of penetration value. 30/40 grade bitumen indicates the penetration value of the bitumen in the range of 30 to 40 at

standard test conditions. Penetration test is applied exclusively to bitumen. Tars being soft, penetration test on these materials cannot be carried out.

5. Observation:

1. Pouring temperature, °C = ……
2. Period of cooling in atmosphere, minutes = ……
3. Room temperature, °C = ……..
4. Period of cooling in water bath, minutes = ……..
5. Actual test temperature, °C = ……..

Readings	Sample No.				Sample No.			
	Test 1	Test 2	Test 3	Mean value	Test 1	Test 2	Test 3	Mean value
Penetrometer dial reading (i) initial (ii) final Penetration value Repeatability, percent								

6. Calculations:

7. Results

For test sample = ……

Standard value = ……

%age error =……

8. Precautions:

9. Remarks:

10. Discussion:

Range of penetration value	Maximum difference
0 – 49	2
50 – 149	4
150 – 249	6

Penetration value	Repeatability	Reproducibility
below 50	1 unit	4 units
Above 50	3 % of their mean	8 % of their mean

EXPERIMENT NO-11

SPECIFIC GRAVITY TEST

1. Objective:

To determine the specific gravity of semi-solid bitumen road tars, creosote and anthracene oil.

2. Apparatus/Equipments Required:

i) Specific gravity bottles of 50ml capacity
ii) Water bath
iii) Bath thermometer – Range 0 to 44^{o}C, Graduation 0.2^{o}C
Take the sample (half the volume of the specific gravity bottles).

3. Theory:

This test is done to determine the specific gravity of semi-solid bitumen road tars, creosote and anthracene oil as per IS: 1202 – 1978. The principle is that it is the ratio of mass of a given volume of bitumen to the mass of an equal volume of water, both taken at a recorded/specified temperature.

4. Procedure:

1) Clean, dry and weigh the specific gravity bottle along with the stopper (Weight 'A').

2) Fill the specific gravity bottle with freshly boiled distilled water and insert the stopper firmly. Keep it in the water bath having a temperature of 27.0 + 1^{o}C for not less than half an hour and weigh it (Weight 'B').

3) Weigh the specific gravity bottle about half-filled with the material (Weight 'C').

4) Weigh the specific gravity bottle about half-filled with the material and the other half with distilled water (Weight 'D').

5) Weigh the specific gravity bottle completely filled with the material (Weight 'E').

5. Observation:

a. Weigh of specific gravity bottle = A

b. Weigh of specific gravity bottle + Distilled water = B

c. Weigh of specific gravity bottle about half-filled with the material = C

d. Weigh of specific gravity bottle about half-filled with the material and the other half with distilled water = D

e. Weigh the specific gravity bottle completely filled with the material = E

6. Calculations:

i) Specific gravity (Solids and semi-solids) = (C-A)/[(B-A) - (D-C)]
ii) Specific gravity (Liquids) = (E-A)/(B-A)
The average of the two results should be reported.

Table Results of specific gravity test on bitumen by pyknometer method

(i) Grade of bitumen = (ii) Test temperature =

Sample No.	Weight of bottle, g	Weight of bottle + distilled water, g	Weight of bottle + half filled material, g	Weight of bottle + half filled material + distilled water, g	Specific gravity
	a	b	c	D	
1					
2					
3					
Average value					

Specific gravity value =

7. Results

Specific gravity (Solids and semi-solids) =

Specific gravity (Liquids) =

8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-12

MARSHALL STABILITY TEST

1. Objective:

To determine the Marshall stability of bituminous mixture.

2. Apparatus/Equipments required:

i) Marshall stability apparatus

ii) ii) Balance and water bath

3. Procedure:

1) Heat the weighed aggregates and the bitumen separately up to 170^{o}C and 163^{o}C respectively.

2) Mix them thoroughly, transfer the mixed material to the compaction mould arranged on the compaction pedestal.

3) Give 75 blows on the top side of the specimen mix with a standard hammer (45cm, 4.86kg). Reverse the specimen and give 75 blows again. Take the mould with the specimen and cool it for a few minutes.

4) Remove the specimen from the mould by gentle pushing. Mark the specimen and cure it at room temperature, overnight.

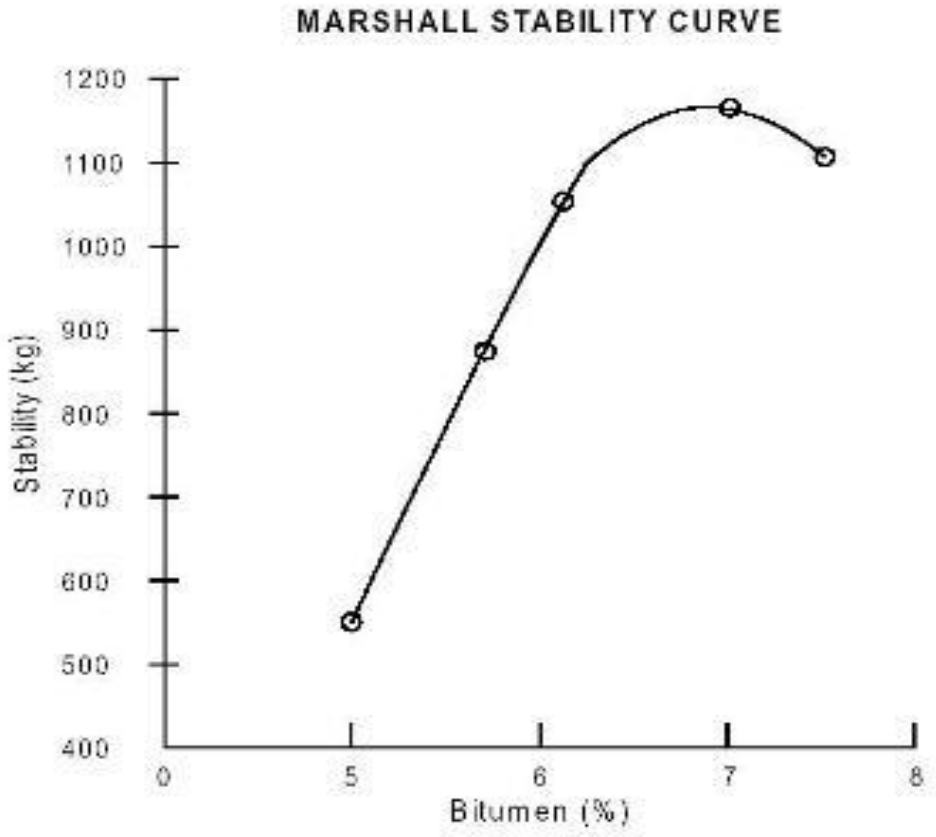
5) A series of specimens are prepared by a similar method with varying quantities of bitumen content, with an increment of 0.5% (3 specimens) or 1 bitumen content.

6) Before testing of the mould, keeps the mould in the water bath having a temperature of 60^{o}C for half an hour.

7) Check the stability of the mould on the Marshall stability apparatus.

4. Results

Plot % of bitumen content on the X-axis and stability in kg on the Y-axis to get maximum Marshall stability of the bitumen mix. A sample plot is given



8. Precautions:

9. Remarks:

10. Discussion:

EXPERIMENT NO-13

BITUMIN CONTENT TEST

1. Objective:

To determine the bitumen content using centrifuge extractor.

2. Apparatus/Equipments required:

1. Centrifuge extractor
2. Miscellaneous - bowl, filter paper, balance and commercial
3. Benzene
4. 500g sample**.**

3. Procedure:

1. If the mixture is not soft enough to separate with a trowel, place 1000g of it in a large pan and warm up to 100^{o}C to separate the particles of the mixture uniformly.

2. Place the sample (Weight ‘A’) in the centrifuge extractor. Cover the sample with benzene, put the filter paper on it with the cover plate tightly fitted on the bowl.

3. Start the centrifuge extractor, revolving slowly and gradually increase the speed until the solvent ceases to flow from the outlet.

5. Repeat the procedure at least thrice, so that the extract is clear and not darker than the light straw colour and record the volume of total extract in the graduated vessel.

6. Remove the filter paper from the bowl and dry in the oven at 110 + 5^{o}C. After 24hours, take the weight of the extracted sample (Weight ‘B’).

4. Observation:

Weight of the sample = A
weight of the extracted sample = B

5. Calculations:

Bitumen content = [(A-B)/B] × 100 %
Repeat the test thrice and average the results.

6. Results

Bitumen content = ……

7. Precautions:

8. Remarks:

9. Discussion:

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