LAB MANUAL

TRANSPORTATION ENGG. LAB.

BY

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PATT – I

TESTS ON AGGREGATES

ABRASION TEST

Aim of the Experiment: To determine the abrasion value of given aggregate sample by conducting LosAngeles abrasion Test.

Apparatus Required:

(i) Los Angeles machine with inside diameter 70cm and inside length of 50cm.

(ii) Abrasive charges having diameter 4.8cm and weight 390 to 445 gm

(iii)I.S Sieve with 1.7mm opening.

(iv)Weighting Balance of 0.1gm accuracy.

(v) Metallic Tray

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 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. 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 course 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.

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 5 kg for grading A, B, C or D and 10 kg for gradings 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 gradings A, B, C and D, for gradings 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 1.70 mm I.S sieve, the material is first separated into two parts and the finer position is taken out and sieved further on a 1.7 mm I.S sieve.
- Let the original weight of aggregate be W_1 gm, weight of aggregate retained on 1.70 mm I.S sieve after the test be W_2 gm.

$$\text{Los Angeles abrasion value \%} = \frac{W_1 - W_2}{W_1} \times 100$$

Two tests are done and the average value to the nearest whole number is reported as abrasion value.

Grading	Weight in gms of each test sample in the size range, mm (Passing and retained on square holes)										Abrasive Charge	
	80-63	63-40	50-40	40-25	25-20	20-12.5	12.5-10	10-6.3	6.3-4.75	4.75-2.36	Number of spheres	Weight of charg, gm
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

Observation and Calculation:

S.NO	Details of sample	Observations	
		1	2
1	Weight of specimen = W_1g		
2	Weight of Specimen retain on 1.7 mm IS Sieve after abrasion test = W_2 g		
3	Percentage wear		
4	Mean value		

Result:

The abrasion value of given aggregate is……..%

Discussion:

IMPACT TEST

Aim of the Experiment:

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

Apparatus Required:

- The apparatus consists of an Impact testing machine: The machine consists of a metal base. A detachable cylindrical steel cup of internal diameter 10.2 cm and depth 5 cm. A metal hammer of weight between 13.5 to 14 kg, 10 cm in diameter and 5 cm long. An arrangement for raising the hammer and allow it to fall freely between vertical guides from a height of 38 cm on the test sample in the cup.
- A cylindrical metal measure having 7.5 cm and depth of 5 cm for measuring aggregates.
- A tamping rod of circular cross section, 1cm in diameter and 23 cm long, rounded at one end.
- I.S. sieve of sizes 12.5 mm, 10 mm and 2.36 mm.
- Balance of capacity not less than 500 gm to weigh accurate up to 0.01 gm.

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%.

Procedure:

- The test sample consists of aggregates passing 12.5 mm sieve and retained on 10mm sieve and dried in an oven for 4 hours at a temperature of 100 ^{0}C to 110 ^{0}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 0.01 gm and taken as W_1 gm.
- 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 38 cm 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 2.36 mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1 gm. 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 2.36 mm 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.
- Two tests are done and the average value to the nearest whole number is reported as aggregate impact value.

$$\text{Aggregate Impact value} = (W_2 / W_1) * 100$$

Observation and Calculation:

Sl No	Details of sample	No of observation	
		1	2
1	Total weight of aggregate sample filling the cylinder measure=W_1gm		
2	Weight of the aggregate passing through 2.36mm is sieve after the test=W_2 gm		
3	Aggregate Impact Value		
4	Mean Value		

Result:

The Aggragate impact Value of the given aggregate is……..%

Discussion:

AGGREGATE CRUSHING STRENGTH TEST

Aim of the Experiment:

To determine crushing strength of a given aggregate

Apparatus Required:

- 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 cm and height 18 cm.
- Steel tamping rod having diameter of 1.6 cm length 45 to 60 cm.
- 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 of 4 tonnes per minute

Theory and Scope:

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. The crushing strength or aggregate crushing value of a given road aggregate is found out as per ***IS-2386 Part- 4***.

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. 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).

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.
- Then the aggregate crushing value is defined as the ratio of weight of fines passing the specified IS sieve(W_2 gm) to the total weight of the sample (W_1 gm)
- Two tests are done and the average value to the nearest whole number is reported as aggregate abrasion value.

Aggregate crushing value= (W_2 / W_1)x100

Observation and Calculation:

No of observations	Total weight of dry aggregate sample($w_1$gm)	Weight of fines passing through 2.36 mm IS Sieve($w_2$gm)	Aggregate Crushing Value (%)	Mean Value
1				
2				

Result:

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

Discussion:

SHAPE TEST *(Flakiness Index)*

Aim of the Experiment: -

To determine the flakiness Index of a given aggregates sample.

Apparatus Required: -

(i) 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 6.3 mm

(ii) Balance to weigh the samples.

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 6.3 mm.

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 (w_1 gm).
- 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 $w_1+w_2+w_3+\ldots\ldots = w$ gm is found. Also the weights of the materials passing each of the specified thickness gauges are found = W_1, W_2, W_3… and the total weight of the material passing the different thickness gauges = $W_1+W_2+W_3+\ldots\ldots = W$ gm 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.

$$\text{Flakiness Index} = \frac{(w_1 + w_2 + w_3 + \ldots\ldots)}{(W_1 + W_2 + W_3 + \ldots\ldots)} x100$$

$$= \frac{w}{W} x100\ \%$$

Observation and Calculation:

Size of aggregate		Thickness gauge (0.6 times the mean sieve) mm	Weight of the fraction consisting of at least 200 pieces in gm	Weight of the aggregate in each fraction retained on thickness gauge, gm
Passing through IS sieve mm	Retained on Is sieve, mm			
63	50	33.9		
50	40	27		
40	25	19.5		
31.5	25	16.95		
25	20	13.50		
20	16	10.80		
16	12.5	8.55		
12.5	10	6.75		
10	6.3	4.89		

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

Discussion:

SHAPE TEST*(Elongation Index)*

Aim OF the Experiment:

To determine the Elongation Index of the given aggregate sample.

Apparatus Required:

(i) Length gauge, I.S-sieves as given in the table

(ii) Balance of accuracy 0.01 gm

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**

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 6.3 mm.

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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+……. = W gm. 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.

$$\text{Elongation Index} = \frac{(x_1 + x_2 + x_3 + ...)}{(W_1 + W_2 + W_3 + ...)} x100 .$$

Observation and Calculation:

Size of aggregate		Length gauge (1.8 times the mean sieve) mm	Weight of the fraction consisting of at least 200 pieces in gm	Weight of the aggregate in each fraction retained on the length gauge, gm
Passing through IS sieve mm	Retained on Is sieve, mm			
63	50	-		
50	40	81		
40	25	58.5		
31.5	25	-		
25	20	40.5		
20	16	32.4		
16	12.5	25.6		
12.5	10	20.2		
10	6.3	14.7		

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

Combined flakiness and elongation index:

Flakiness index of the given aggregate is found out.Then Elongation index of the nonflaky materials of the given aggregate found out and combined flakiness and elongation index is calculated by adding both the flakiness and elongation index of the aggregate sample.

Discussion:

SPECIFIC GRAVITY AND WATER ABSORPTION TEST

Aim of the Experiment:

To determine the absorption and specific gravity of aggregates.

Apparatus Required:

(i) A wire basket of not more than 6.3 mm mesh or a perforated container of convenient size with thin wire hangers for suspending it from the balance.

(ii) A thermostatically controlled oven to maintain temperature of 100 °C to 110 °C.

(iii) A container for filling water and suspending the basket.

(iv) An airtight container of capacity similar to that of the basket.

(v) A balance of capacity about 5 kg. weight accurate to 0.5 gm, and of such a type and shape as to permit weighing of the sample container when suspended in water.

(vi) A shallow tray and two dry absorbent clothes.

Theory and Scope:

The specific gravity of an aggregate is considered to be a 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 nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

Procedure:

(i) 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 °C to 32 °C with a cover of at least 50 mm 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 25 mm 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 hours

(ii) The basket and the sample are then weighed while suspended in water at a temperature of 22 °C to 32 °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 W_1 gm. 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 absorbent clothes. The empty basket is then returned to the tank of water. jolted 25 times and weight in water W_2 gm.

(iii) 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 W_3 gm. The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110 °C for 24 hours. It is then removed from the oven, cooled in an airtight container and weighed W_4 gm.

(iv) Two tests are done and the average value to the nearest whole number is reported as aggregate abrasion value.

Observation and 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) = Ws g.

Weight of saturated surface dry aggregate in air= W_3 g

Weight of oven dried aggregate=W_4 g

Weight of water equal to the volume of the aggregate=(W_3-Ws) g

Specific Gravity= (Weight of aggregate/Weight of equal volume of water)

$= W_4 / (W_3 - Ws)$

Water absorption= percent by weight of water absorbed in terms oven dried weightof aggregates.

$= [(W_3 - W_4) / W_4] \times 100$

Sl No	Description	No of observations	
		1	2
1	Weight of saturated aggregate suspended in water with the basket = W_1 g		
2	Weight of basket suspended in water= W_2 g		
3	Weight of saturated aggregate in water= (W_1-W_2) = Ws g.		
4	Weight of saturated surface dry aggregate in air= W_3 g		
5	Weight of oven dried aggregate=W_4 g		
6	Specific Gravity		
7	Water Absorption		
8	Mean Specific Gravity		
9	Mean Water Absorption		

Results:

Specific gravity of given aggregate is…….& Water Absorption of given aggregate…….

Discussion:

SOUNDNESS TEST

Aim of the Experiment:
To determine the soundness value of aggregate.

Apparatus Required:

(i) The apparatus required for the test are containers for aggregates, sieves (63, 50. 40, 31.5, 20, 16, 10,8,4.75 & 4 mm).

(ii) Balance of capacity 5kg to weight accurate to at least 0.1 g

(iii) Oven to maintain 105 °C to 110 °C.

(iv) Na_2SO_4 or $MgSO_4$ solution

Theory and Scope:

This test is intended to study the resistance of aggregates to weathering action.In order to quicken the effect of weathering due to alternate wet-dry and or freeze-thaw cycles in the laboratory, the resistance to disintegration of aggregate is determined by soaking the specimen in saturated solution of sodium sulphate or magnesium sulphate.

Soundness of aggregates: Loss with Sodium Sulphate — 5 cyclesMax.12%.

Loss with Magnesium Sulphate — 5 cyclesMax.18%.

Procedure:

- Saturated solution of Sodium sulphate(the anhydrous Na_2SO_4 or the crystalline $Na_2SO_4$10H20) is prepared in water at a temperature of 25 °C to 30 °C. The solution is maintained at a. temperature of 27 °C and stirred at frequent intervals, until it is used. At the time of using the solution should have a specific gravity of not less than 1.151 and not more than 1.171 and discolored solution should not be used. It may be necessary to use not less than 420 gm of anhydrous salt or 1300 gm of the crystalline decahydrate salt per liter of water.
- Alternatively saturated solution of Magnesium sulphate may be prepared by dissolving either anhydrous ($MgSO_4$ or crystalline ($MgS0_4$7H20) magnesium sulphate. At the time of using, the solution should have a specific gravity of not less than 1.295 and not more than

1.308. Not less than 400g of the anhydrous salt or 1600 gm of the crystalline heptahydrate may be used per liter of water.

- The specimen of coarse aggregate for the test may be prepared after removing the fraction finer than 4.75 IS sieve. The sample should be of such a size that it would yield not less than the following amounts of the different sizes which should be available in amount of 5 percent or more.

  (i) 20 mm to l0 mm-1000 g
  10 mm to 4.75 mm-300 g
  consisting of 20 to 12.5 mm— 67%
  12.5 to10 mm — 33%

  (ii) 40 mm to 20 mm-1500 g
  consisting of 40 to 25 nnn — 67%
  25 to 20 mm— 33%

  (iii) 63 mm to 40 mm-3000 g
  consisting of 63 to 50 mm— 50%
  50 mm to 40 mm— 50%

  (iv) 80min and large sizes by
  20mm spread in sieve size, - 3000 g
  each fraction

- The sample of coarse aggregate should be thoroughly washed and dried to a constant weight at 105 °C to 110 °C and is separated to different size ranges, as given above, by sieving. The proper weight of the sample for each fraction is weighed and placed in separate containers for the test. In the case of fraction coarser than 20 mm. the particles are also counted. The samples are immersed in the prepared solution of sodium sulphate or magnesium sulphate for 16 to 18 hours in such a manner that the solution covers them to a depth of at least 15 mm. The containers are kept covered to reduce evaporation and during the period of immersion, the temperature of the solution is maintained at 27 °C+/-1 °C

- After the immersion period, the aggregates are removed from the solution. drained for about 15 minutes. and placed in the drying oven maintained at a temperature of 105 °C to 110 ^{0}C. The samples are dried to a constant weight at this temperature by checking the weights after 4 hours up to 18 hours. When the successive weights differ by less than 12mg, it may be considered that constant weight has been attained and then it may be allowed to cool to room temperature. Then the aggregates are again immersed in the prepared solution, for the next cycle of immersion and drying. The number of cycles of alternate immersion and drying are minimum 5 for road aggregates.
- After completion of the final cycle, the sample is cooled washed free from the sulphat. This may be determined when there is no more reaction of the wash water with barium chloride (i.e.. when there is no white precipitation when barium chloride is added to wash. water, it can be said that there is no sulphate with wash water). Each fraction of the sample is then dried to constant temperature of105 °C to110 °C and weighed. Coarse aggregate fractions are sieved by IS sieves of sizes indicated below:

Size of aggregate	Sieve size used to determine loss
63 to 40 mm	31.5 mm
40 to 20 mm	16.0 mm
20 to 10 mm	8.0 mm
10 to 4.75 mm	4.0 mm

- Each fraction of aggregate is examined visually to see if there is any evidence of excessive splitting, crumbling or disintegration of the grains. A combined sieve analysis of all the materials subjected to the above test cycles, may also be carried out to note the variation from the original grain size distribution of the sample.

Observation and Calculation:

Sieve Size, mm		Grading original sample percent	Weight of test fraction before test, g	%ge passing finer sieve after test (actual % loss)	Weighted average (corrected% loss)
Passing	Retained				
63	40				
40	20				
20	10				
10	4.75				
Total		100	-	-	

Results:

The soundness value of the aggregate is ……%

Discussion:

PATT – II

TESTS ON BITUMEN

PENETRATION TEST

Aim of the Experiment:

To determine the hardness or softness of given VG binder.

Apparatus Required:

(i) Cylindrical metallic Container having 55mm in diameter and 35mm to 57mm height
(ii) Steel Needle having diameter 3mm with conical end
(iii) Water Bath
(iv) Penetrometer
(v) Transfer Tray

Theory and Scope:

The consistency of bituminous materials varies depending upon several factors such as constituents, temperature, etc. As temperature ranges between 25 ºC and 50 ºC 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 for the purpose of grading them indirectly; by measuring the depth (in units of one tenth of millimetre or one hundredth of a centimetre) 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 mm) of a standard needle in a bitumen sample maintained at 25 ^{0}C during five seconds, the total weight of the needle assembly being 100 gm. The softer the bitumen, the greater will be the penetration. The test is conducted as per IS-1203 for paving bitumen.

Procedure:

- The bitumen is softened to a pouring consistency between 75 ºC - 100 ºC 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 13 ºC for one hour. Then they are placed in temperature controlled water bath at a temperature of 25 ºC for a period of one hour.
- The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100 gm.
- 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 5.0 sec.
- At least 3 measurements are made on this sample by testing at distance of not less than 10 mm apart. The difference between the initial and final penetration readings are taken as the penetration value.

Observation and Calculation:

Readings	No. of observations		
	1	2	3
Penetrometer Dial Initial Reading			
Penetrometer Dial Final Reading			
Penetration Value			
Mean Value			

Result:

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

Discussion:

FLASH AND FIRE POINT TEST

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

Apparatus Required:

(i) Pensky-Martens closed cup tester

(ii) Thermometer

(iii) Heating source

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 vapor 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”.

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 5 º C to 6 ºC 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.

Observation and Calculation:

Tests property	No. of observations			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.

Discussion:

SOFTENING POINT OF BITUMEN

Aim of the Experiment:

To determine the softening point of given bitumen sample.

Apparatus Required:

- **(i)** Ring and Ball apparatus
- **(ii)** Water bath with stirrer
- **(iii)** Thermometer.
- **(iv)** Steel balls each of 9.5 mm and weight of 2.5±0.05 gm.

Theory and Scope:

Softening point denotes the temperature at which the bitumen attains a particular degree of softening underthe specifications of test. The test is conducted by using Ring and Ball apparatus. A brass ring containing testsample of bitumen is suspended in liquid like water at a given temperature. A steel ball is placed upon the bitumen sample and the liquid medium is heated at a rate of 5 ^{o}C per minute. Temperature is noted when the softened bitumen touches the metal plate which is at a specified distance (25 mm) below. Generally, higher softening point indicates lower temperature susceptibility and is preferred in hot climates.

Procedure:

- Sample material is heated to a temperature between 75 ºC and 100 ºC 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 5 ºC. 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 5 ºC 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 ºC, glycerin is used for heating medium and the starting temperature is 35 ºC instead of 5 ºC.
- The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening point value.

- Two tests are conducted and the mean value is reported as softening point.

Observation and Calculation:

Test Property	No. of observations	
	1	2
Temperature in ^{0}C at which Ist ball touch the bottom plate		
Temperature in ^{0}C at which IInd ball touch the bottom plate		
Mean value		
Final softening point temperature		

Result:

The softening point value of given bitumen sample is _____ºC

Discussion:

SPECIFIC GRAVITY OF BITUMEN

Aim of the experiment:

To determine the specific gravity of given Bituminous material.

Apparatus required:

(i) Specific gravity bottle,

(ii) Weighing balance

(iii) Distilled water.

Theory and Scope:

In paving jobs, to classify a binder, density property is of great use. In most cases bitumen is weighed, but when used with aggregates, the bitumen is converted to volume using density values. The density of bitumen is greatly influenced by its chemical composition. Increase in aromatic type mineral impurities cause an increase in specific gravity. The specific gravity of bitumen is defined as the ratio of mass of given volume of bitumen of known content to the mass of equal volume of water at 27 ^{o}C. The specific gravity of bitumen varies from 0.99 to 1.02.

Procedure:

- The clean, dried specific gravity bottle is weighed let that be W_1 gm
- Than it is filled with fresh distilled water and then kept in water bath for at least half an hour at temperature 27 ^{o}C±0.1 ^{o}C.
- The bottle is then removed and cleaned from outside. The specific gravitybottle containing distilled water is now weighed. Let this be W_2gm.
- Then the specific gravity bottle is emptied and cleaned. The bituminous material is heated to a pouring temperature and the material is poured half the bottle; by taking care to prevent entry of air bubbles. Then it is weighed. Let this be W_3 gm.
- The remaining space in specific gravity bottle is filled with distilled water at 27 ^{o}C and is weighed. Let this be W_4 gm. Then specific gravity of bituminous material is given by the following formula

$$(W_3 - W_1) / [(W2-W1) - (W4-W3)]$$

- Three tests are conducted and the mean value is reported as specific gravity of the bitumen.

Observation and Calculation:

Sl No	Details of sample	No of observations		
		1	2	3
1	Weight of the empty specific gravity bottle=W_1 gm			
2	Weight of the specific gravity bottle filled with water=W_2 gm			
3	Weight of the specific gravity bottle half filled with bitumen=W_3 gm			
4	Weight of specific gravity bottle half filled with bitumen & remaining part filled with water=W_4 gm			
5	Specific Gravity			
6	Mean Specific Gravity			

Result:

The specific gravity of given bituminous binder is _____.

Discussion:

DUCTILITY TEST OF THE BITUMEN

Aim of the Experiment:

To determine the ductility value of a given sample of bitumen.

Apparatus required:

(i) Briquette mould having(length – 75mm, distance between clips – 30mm, width at mouth of clips – 20mm, cross section at minimum width – 10mm x10mm),

(ii) Ductility machine with water bath and a pulling device at a precaliberated rate,

(iii) Knife,

(iv) Thermometer.

Theory:

Ductility is the property of bitumen that permits it to undergo great deformation or elongation. Ductility isdefined as the distance in cm, to which a standard sample or briquette of the material will be elongated withoutbreaking. Dimension of the briquette thus formed is exactly 1 cm square. The bitumen sample is heated andpoured in the mould assembly placed on a plate. These samples with moulds are cooled in the air and then inwater bath at 27o C temperature. The excess bitumen is cut and the surface is levelled using a hot knife. Thenthe mould with assembly containing sample is kept in water bath of the ductility machine for about 90 minutes. The sides of the moulds are removed, the clips are hooked on the machine and the machine is operated. Thedistance up to the point of breaking of thread is the ductility value which is reported in cm. The ductility valuegets affected by factors such as pouring temperature, test temperature, rate of pulling etc. A minimum ductility value of 75 cm has been specified by the BIS.

Procedure :

- Melt the bituminous test material completely at a temperature of 75 ^{o}C to 100 ^{o}C above the approximate softening point until it becomes thoroughly fluid
- Strain the fluid through IS sieve 30.
- After stirring the fluid, pour it in the mould assembly and place it on a brass plate
- In order to prevent the material under test from sticking, coat the surface of the plate and interior surface of the sides of the mould with mercury or by a mixture of equal parts of glycerin and dextrin

- After about 30 – 40 minutes, keep the plate assembly along with the sample in a water bath. Maintain the temperature of the water bath at 27 ^{o}C for half an hour.
- Remove the sample and mould assembly from the water bath and trim the specimen by leveling the surface using a hot knife.
- Replace the mould assembly in water bath maintained at 27 ^{o}C for 80 to 90 minutes
- Remove the sides of the moulds
- Hook the clips carefully on the machine without causing any initial strain
- Adjust the pointer to read zero
- Start the machine and pull two clips horizontally at a speed of 50 mm per minute
- Note the distance at which the bitumen thread of specimen breaks.
- Two or more tests conducted and the mean of three observations, rounded to nearest whole number recorded as the Ductility Value.

Observations and Calculations:

Sl No	Details of sample	No of observations		
		1	2	3
1	Initial Reading=W_1cm			
2	Final Reading=W_2 cm			
3	Ductility=W_1-W_2			
4	Mean Value			

Results:

The Ductility value of given bitumen sample is _____

Discussion:

VISCOSITY TEST OF BITUMINOUS MATERIAL

Aim of the Experiment:

To determine the viscosity of a given bituminous binder.

Apparatus required:

(i) A orifice viscometer (one of 4.0mm diameter used to test cut back grades 0 and 1 and 10 mm orifice to test all other grades),

(ii) water bath,

(iii) Stirrer

(iv) Thermo meter.

Theory and Scope:

Viscosity denotes the fluid property of bituminous material and it is a measure of resistance to flow. At the application temperature, this characteristic greatly influences the strength of resulting paving mixes. Low or high viscosity during compaction or mixing has been observed to result in lower stability values. At high viscosity, it resists the compactive effort and thereby resulting mix is heterogeneous, hence low stability values. And at low viscosity instead of providing a uniform film over aggregates, it will lubricate the aggregate particles. Orifice type viscometers are used to indirectly find the viscosity of liquid binders like cutbacks and emulsions. The viscosity expressed in seconds is the time taken by the 50 ml bitumen material to pass through the orifice of a cup, under standard test conditions and specified temperature. Viscosity of a cutback can be measured with either 4.0 mm orifice at 25 ^{o}C or 10 mm orifice at 25 ^{0}C or 40 ^{o}C.

Procedure:

- Adjust the tar viscometer so that the top of the tar cup is leveled.
- Select the test temperature. Heat the water in water bath to the temperature specified for the test and maintains it within $\pm 0.1^{0}$C of the specified temperature throughout the duration of test. Rotate the stirrer gently at frequent intervals or perfectly continuously
- Clean the tar cup orifice of the viscometer with a suitable solvent and dry thoroughly
- Warm and stir the material under examination to 20 ^{0}C above the temperature specified for test and cool, while continuing the stirring. When the temperature falls slightly above the specified temperature, pour the tar into the cup until the leveling peg on the valve rod is just immersed when the latter is vertical.

- Pour into the graduated receiver 20 ml of mineral oil, or one percent by weight solution of soft soap, and place it under the orifice of the tar cup.
- Place the other thermometer in the tar and stir until the temperature is within ±0.1 ^{0}C of the specified temperature. When this temperature has been reached, suspend the thermo meter coaxially with the cup and with its bulb approximately at the geometric center of the tar.
- Allow the assembled apparatus to stand for five minutes during which period the thermometer reading should remain within 0.05 ^{0}C of the specified temperature.
- Remove the thermometer and quickly remove any excess of tar so that the final level ison the central line of the leveling peg when the valve is in vertical position.
- Lift the valve and suspend it on valve support
- Start the stop watch when the reading in the cylinder is 25 ml and stop it when it is 75 ml. note the time in seconds
- Report the viscosity as the time taken in seconds by 50 ml of tar to flow out at the temperature specified for the test.
- Three tests are conducted and mean of the three observations recorded as viscosity of bituminous material.

Observations and Calculations

Sl No	Details of sample	No of observation		
		1	2	3
1	Test Temperature			
2	Time taken to flow 50cc of the binder			
3	Viscocity (sec)			
4	Mean Viscocity			

Results:

The Viscosity value of given bitumen sample is _____sec

Discussion:

BITUMEN CONTENT TEST

Aim of the Experiment:

To determine quantity of bitumen in hot-mix paving mixtures and pavement samples.

Apparatus required:

(i) Centrifuge Extractor
(ii) Weighing Balance
(iii) Benzene or Trichloroethane
(iv) Filter paper

Theory and Scope:

This type of test used for removing all the asphalt from a bituminous mixture using a cold solvent (Benzene or Trichloroethane) in order to obtain the asphalt content of the mix.

Procedure:

- Weight a 1000 gm sample of asphalt mix and it is taken W_1 gm
- Place the aggregate in the bowl of the extraction apparatus.
- Cover the sample in the bowl with benzene or trichloroethane and allow it to soak for one hour.
- Weight filter ring and then fit it around the edge of the bowl and clamp the cover of the bowl tightly.
- Place a beaker under drain to collect the extract.
- Place the bowl in a centrifuge and rotate it gradually to increase the speed upto 3600 rpm. Rotate until the solvent ceases to flow from the outlet.
- Stop the centrifuge, add 200 ml of trichoroethane or benzene is added and rotate it again.
- Repeat the procedure until the extract is no longer cloudy and if fairly light in color.
- Remove the filter ring from the bowl and dry it first in the air and then in the oven at 115 ^{0}C to a constant weight and weight it.
- Collect back the fine material that might have passed through the filter, by centrifuging. Wash and dry the material to a constant weight, as before.

- Calculate the percentage of binder in the bituminous mix sample as follows:

Percentage of Binder = $\frac{W1-(W2+W3+W4)}{W1}$ x 100

W_1 =Weight of the mix before extraction, gm
B = Weight of filter paper before extraction, gm
W_2 =Weight of the mix after extraction, gm
D = Weight of filter paper after extraction, gm
W_3 =Weight of filler collected in filter paper, gm=B-D
W_4 =Weight of filler collected from extract after allowing for setting, gm

- Three tests are conducted and the mean of three tests to the nearest whole number reported as stripping value or bitumen content of the given mix.

Observations and Calculations:

Sl No	Details of sample	No of observation		
		1	2	3
1	Weight of the mix before extraction= W_1 gm			
	Weight of filter paper before extraction=B gm			
2	Weight of the mix after extraction= W_2 gm			
	Weight of filter paper after extraction=D gm			
3	Weight of filler collected in filter paper= W_3 gm=B-D			
4	Weight of filler collected from extract after allowing for setting= W_4 gm			
5	Percent Binder Content			
7	Mean Value			

Results:

The percentage of the bitumen in the given sample is _____

Discussion:

BITUMINOUS MIX DESIGN BY MARSHALL METHOD

Aim of the Experiment: To determine optimum binder content of given bituminous mix by Marshall Method of mix design.

Apparatus required:

(i) Mould assembly
(ii) sample extractor
(iii) compaction pedestal and hammer
(iv) breaking head
(v) loading machine flow meter
(vi) thermometers
(vii) water bath
(viii) oven

Theory:

In this method, the resistance to plastic deformation of cylindrical specimen of bituminous mixture is measured when the same is loaded at the periphery at 5 cm per minute. This test procedure is used in designing and evaluating bituminous paving mixes. There are two major features of the Marshall method of designing mixes (i) density-void analysis (ii) stability-flow test. The Marshall stability of the mix is defined as a maximum load carried by a compacted specimen at a standard test temperature at 60 ^{o}C. The flow value is the deformation at which the Marshall test specimen undergoes during the loading upto the maximum load, in 0.25 mm unit. In this test an attempt is made to obtain optimum binder content for the type of aggregate mix and traffic intensity.

Procedure:

(i) The coarse aggregates, fine aggregates and mineral filler material should be proportioned and mixed in such a way that final mix after blending has the graduation within the specified range.

Sieve size, mm	Percent passing, by weight	
	Grade I	Grade II
20	-	100
12.5	100	80-100
10	80-100	70-90
4.75	55-75	50-70
2.36	35-50	35-50
0.600	18-29	18-29
0.300	13-23	13-23
0.150	8-16	8-16
0.075	4-10	4-10
Binder content, percent by weight of mix	5-7.5	5-7.5

(ii) Approximately 1200 grams of aggregates and filler are taken and heated to a temperature of 175 ^{0}C to 195 ^{0}C.

(iii) The compaction mould assembly and rammer are cleaned and kept pre- heated to a temperature of 100 ^{0}C to 145 ^{0}C. The bitumen is heated to temperature of 121 ^{o}C to 138 ^{0}C and the required quantity of first trial percentage of bitumen is added to the heated aggregate and thoroughly mixed using a mechanical mixer or by hand mixing with trowel.

(iv) Then the mix is heated and a temperature of 154 ^{0}C to 160^{0}C is maintained and then the mix is transferred into the pre-heated mould and compacted by giving 50 blows on either side at temp. of 138 ^{0}C to 149^{0}C.

(v) The weight of the mixed aggregate taken for the preparation of the specimen may be suitably altered to obtain a compacted thickeness of 63.5 +/- 3.0 mm.

(vi) Three or four specimens may be prepared using each trial bitumen content.

(vii) The specific gravity values of different aggregates, filler and bitumen used are determined first. The theoretical specific gravity of the mix is determined.

$$G_a = \frac{100}{\frac{W1}{G1}+\frac{W2}{G2}+\frac{W3}{G3}+\frac{W4}{G4}}$$

G_a= Average specific Gravity

W_1=Percent by weight of coarse aggregate

W_2=Percent by weight of fine aggregates

W_3=Percent by weight of filler

W_4=Percent by weight of bitumen in total mix

G_1=Apparent specific gravity of coarse aggregate

G_2=Apparent specific gravity of fine aggregates

G_3=Apparent specific gravity of filler

G_4=Apparent specific gravity of bitumen in total mix

$$G_t = \frac{100}{\frac{100-Wb}{Ga}+\frac{Wb}{Gb}}$$

G_t =Theoritical maximum specific gravity

W_b=Percent by weight of bitumen content

G_b=specific gravity of bitumen

(viii) Soon after the compacted bituminous mix specimens have cooled to room temperature, the weight, average thickness and diameter of the specimen are noted. The specimens are weighted in air and also suspended in water.

(ix) The bulk density value(G_b) of the specimen if calculated from weight and volume. The voids analysis are made as given below:

$$Vv, \% = \frac{100(Gt-Gb)}{Gt}$$

$$Vb, \% = G_b \times \frac{W4}{G4}$$

$$VMA, \% = Vv + Vb$$

$$VFB, \% = \frac{100\,Vb}{VMA}$$

Vv=air voids in the mix, %

Vb=volume of bitumen

VMA=voids in mineral aggregate, %

VFB=voids filled with bitumen, %

(x) Then the specimen to be tested is kept immersed under water in a thermostatically controlled water bath maintained at 60 ^{0}C ± 1 ^{0}C for 30 to 40 minutes.

(xi) The specimens are taken out one by one, placed in the marshal test head and the marshal stability value and flow are noted.

(xii) The corrected Marshall Stability value of each specimen is determined by applying the appropriate correction factor, if the average height of the specimen is not exactly 63.5mm.

Correction Factor for Marshall Stability value

Volume of specimen in cc	Thickness of specimen in mm	Correction factor
457-470	57.1	1.19
471-482	58.7	1.14
483-495	60.3	1.09
496-508	61.9	1.04
509-522	63.5	1.00
523-535	65.1	0.96
536-546	66.7	0.93
547-559	68.3	0.89
560-573	69.9	0.86

(xiii) Five graphs are plotted with values of bitumen content against the values of Marshall Stability, Flow value, Unit weight, Percent voids in total mix, Percent voids filled with bitumen.

(xiv) Let the bitumen contents corresponding to maximum stability be B1, corresponding to maximum unit weight be B2, and that corresponding to the percent air voids in total mix (at 4.0%) be B3. Then the optimum bitumen content for mix design is given by: Bo = (B1+B2+B3)/3

Result:

The optimum binder content of the given mix is _____

Discussion:

SOLUBILITY TEST

Aim of the Experiment:

To determine the solubility in carbon disulphide for asphaltic bitumen.

Apparatus required:

(i) Conical glass flask of 200 ml capacity
(ii) Filter paper
(iii) Weighing machine
(iv) Solvents (carbon disulphide or carbon tetrachloride)

Theory:

Pure bitumen is completely soluble in solvents like carbon disulphide and carbon tetrachloride. Hence any impurity in bitumen in the form of inert minerals, carbon, salts etc. could be quantitatively analysed by dissolving the samples of bitumen in any of the above two solvents. The insoluble material should be preferably less than 1.0 %.The minimum proportion of bitumen soluble in carbon disulphide is specified as 99 %.

Procedure:

- Take a bitumen sample of 2 gm (W_1 gm) and 100 ml of solvent (carbon disulphide or carbon tetrachloride).
- Stir the contents of the flask and then allow it to stand, loosely corked,for aperiod of 1 hour.
- Filter the contents of the flask through Gooch crucible prepared which has been weighted to the nearest 0.001 gm.
- Moisten the asbestos pad with carbon disulphide before commencing filtration and filter at a rate of not more than two drops per second at first.
- The filter shall be quite clear.
- Transfer the insoluble matter remaining in the flask to the crucible by washing on the flask with a stream of carbon disulphide from a wash bottle.
- Wash the material retained in the crucible with successive small amounts of carbon disulphide until a filtrate is obtained which is not discolored.
- Allow the crucible to dry in air for 30 minutes after which place it in an oven at 100 ^{0}C to 110 ^{0}C for one hour.
- Allow the crucible to cool in a desiccator and then weight (W_2 gm).
- Matter soluble in carbon disulphide, percent = $\frac{(W1-W2)}{W1} \times 100$
- Two tests are conducted and the mean of two tests to the nearest 0.05 %reported as soluble bitumen content.

Observations and Calculations:

Sl No	Details of sample	No of observations	
		1	2
1	Weight of the dry sample taken for the test = W_1 gm		
2	Weight of the insoluble material retained in the Gooch crucible = W_2 gm		
3	Matter soluble in carbon disulphide, percent		
4	Mean Value		

Results:

The soluble bitumen content of a given bitumen sample is _____.

WATER CONTENT TEST

Aim of the Experiment:

To determine the amount of water content in a given bitumen sample.

Apparatus required:

(i) Flask of 500 ml capacity
(ii) Condenser
(iii) Receiver
(iv) A 100 ml graduated cylinder
(v) Heater
(vi) Solvent (Petroleum or coal tar naphtha free from water)

Theory:

It is desirable that the bitumen contains minimum water content to prevent foaming of the bitumen when it is heated above the boiling point of water. The maximum water content in bitumen should not exceed 0.2 % by weight.

Procedure:

- Take about 100 gm of the sample, place it in a flask and add 100 ml of solvent.
- Attach the flask to the Dean and Stark condensing and collecting system and heat the flask at such a rate that the condensate falls from the end of the condenser at a rate of two or five drops per second.
- Continue the distillation until condensed water is no longer visible in any part of the apparatus except the bottom of the graduated tube and until the volume of water collected remains constant for a period not less than five minutes.
- Remove the persistent ring of condensed water in the condenser tube, if any, by increasing the rate of distillation by a few drops per second.
- Wash droplets of water which adhere to the lower end of the condenser tube into the receiver with solvent liquid using the spray tube.
- Insert a loose plug of cotton wool in the top of the condenser tube to prevent the condensation of atmospheric moisture in the condenser tube.
- The weight of the water condensed and collected is expressed as percentage by weight of the original sample.

Observations and Calculations:

Results:

The amount of water content in a given bitumen sample is _____