Techno India NJR Institute of Technology

B.Tech. VII Semester

Course File

Road Material Testing Lab (7CE4-21)

Session 2022-23

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Syllabus

IV Year- VII & VIII Semester: B. Tech. (Civil Engineering)

7CE4-21: Road Material Testing Lab

Credit 1 **Max. Marks: 50(IA:30, ETE:20)**

0L+0T+2P

1. Aggregate ImpactTest
2. To determine the Angularity Number, Flakiness Index & Elongation Index of aggregates
3. Los Angeles AbrasionTest
4. Aggregate Crushing ValueTest
5. Standard Tar Viscometer Test for given bitumensample
6. Ductility Test for a given bitumensample
7. To determine the softening point for given sample ofbitumen.
8. Marshall StabilityTest
9. FloatTest
10. Preparation of Dry lean concrete mix and testing of itsstrength

Course Overview:

Road material testing is the process of evaluating the physical and mechanical properties of materials used in road construction and maintenance. This may include testing for characteristics such as strength, durability, and elasticity. Common tests include compressive strength testing, flexural strength testing, and abrasion resistance testing. The course overview would likely cover the various types of tests used, the equipment and procedures involved in performing the tests, and the interpretation of test results. It may also cover topics such as quality control and standard specifications for road materials.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	**Analysis**	Understand the importance and determination of physical properties of aggregates.
2	**Evaluation**	Understand the importance and determination of physical properties of bitumen.
3	**Synthesis**	Evaluate and analyze the suitability of materials from data collected by physical tests done on aggregates and bitumen.
4	**Synthesis**	Design of different bituminous layers of flexible pavement and compare their results with IRC/MoRTH recommendations.
5	**Application**	Prepare a formal report describing complex design procedures and results.

Prerequisites:

1. Basic understanding of civil engg. Material.
2. Understanding of transportation engg.
3. Basic understanding of Indian road codes.

Course Outcome Mapping with Program Outcome:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
Course Outcome	3	2	2	2	2	1	1	1	2	1	1	2	2	2	2
	2	2	1	1	1	2	1	1	2	2	2	1	1	2	2
	3	2	2	2	2	1	1	1	2	1	1	2	2	2	2
	3	3	3	2	2	1	2	1	2	1	1	1	2	2	1
	3	3	3	2	2	1	2	1	2	1	1	1	2	2	1
CO471 (AVG)	2.8	2.4	2.2	1.8	1.8	1.2	1.4	1	2	1.2	1.2	1.4	1.8	2	1.6

Course Coverage Module Wise:

Lab No.	Exp. No.	Topic
1	1	Aggregate Impact Test.
2	2	To determine the Angularity Number, Flakiness Index & Elongation Index of aggregates.
3	3	Los Angeles Abrasion Test.
4	4	Aggregate Crushing Value Test.
5	5	Standard Tar Viscometer Test for given bitumen sample.
6	6	Ductility Test for a given bitumen sample.
7	7	To determine the softening point for given sample of bitumen.
8	8	Marshall Stability Test.
9	9	Float Test.
10	10	Preparation of Dry lean concrete mix and testing of its strength.

Faculty Lab Manual Link

https://drive.google.com/file/d/12H_9odeY1SSXebi4FIOcsI31kBaatijg/view?usp=share_link

Assessment Methodology:

1. Practical exam.
2. Internal exams and Viva Conduct.
3. Final Exam (practical paper) at the end of the semester.

SPECIFIC GRAVITY AND WATER ABSORPTION TESTS OF AGGREGATES

Aim : To determine the specific gravity and water absorption of the given aggregate.

Theory : The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Aggregates having low specific gravity are generally weaker than those with high specific gravity. This property helps in a general identification of aggregates. Water absorption also gives an idea on the internal structure of aggregate. Aggregates having more absorption are more porous in nature and are generally considered unsuitable, unless found to be acceptable based on strength, impact and hardness tests.

Apparatus : The apparatus required for these tests are:

1. A balance of at least 3 kg capacity, with a accuracy to 0.5 g.

2. An oven to maintain a temperature range of 100 to 110-C.

3. 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.

4. A container for filling water and suspending the wire basket in it.

5. An airtight container of capacity similar to that of basket, a shallow tray and two dry absorbent clothes. 6. Pycnometer of 1000 ml for aggregates finer than 6.3 mm and Specific gravity bottle

Procedure for aggregate coarser than 10 mm :

1. About 2 kg of aggregate sample is taken, washed to remove fines and then placed in the wire basket. The wire basket is then immersed in water, which is at a temperature of 22-C to 32-C.

2. Immediately after immersion the entrapped air is removed from the sample by lifting the basket 25 mm above the base of the tank and allowing it to drop, 25 times at a rate of about one drop per second.

3. The basket, with aggregate are kept completely immersed in water for a period of 24 ± 0.5 hour.
4. The basket and aggregate are weighed while suspended in water, which is at a temperature 5. The basket and aggregates are removed from water and dried with dry absorbent cloth.
6. The empty basket is suspended back in water tank and weighed.
7. The surface dried aggregates are also weighed.
8. The aggregate is placed in a shall C in the oven for 24 hours. Later, it is cooled in an airtight container and weighed.

Procedure for specific gravity determination of aggregate finer than 10 mm :

1. A clean, dry pycnometer is taken and its empty weight is determined.

2. About 1kg of clean sample is taken into the pycnometer, and it is weighed.

3. C is filled up in the pycnometer with aggregate sample, to just immerse sample.

4. Immediately after immersion the entrapped air is removed from the sample by shaking pycnometer, placing a finger on the hole at the top of the sealed pycnometer.

5. Now the pycnometer is completely filled up with water till the hole at the top, and after confirming that there is no more entrapped air in it, it is weighed.

6. The contents of the pycnometer are discharged, and it is cleaned.

7. Water is filled up to the top of the pycnometer, without any entrapped air. It is then weighed.

For mineral filler, specific gravity bottle is used and the material is filled upto one-third of the capacity of bottle. The rest of the process of determining specific gravity is similar to the one described for aggregate finer than 6.3 mm.

Observations and Calculations :

1. Aggregate coarser than 6.3 mm

Table 1.1 Observation table for Specific gravity and water absorption

S.No	Details	Observed Values
1	Mass of saturated aggregate and basket in water : W1 g	
2	Mass of basket in water: W2 g	
3	Mass of saturated surface dry aggregates in air: W3 g	
4	Mass of oven dry aggregates in air: W4 g	
5	Specific Gravity: W4 / [W3 (W1 - W2)]	
6	Apparent Specific Gravity:	

	W4 / [W4 (W1 - W2)]	
7	Water Absorption: [(W3 W4) / W4] x 100	

Results:

Specific Gravity =

Apparent Specific Gravity =

Water Absorption (in %) =

2. Aggregate of size finer than 6.3 mm

Table 1.2 Observation table for Specific gravity test (finer than 6.3 mm)

S.No	Details	Observed Values
1	Mass of saturated surface dry sample in air: W4 g	
2	Mass of aggregates, Pycnometer and water: W3 g	
3	Mass of Pycnometer(or glass jar) filled with distilled water : W2 g	
4	Mass of oven dry aggregate in air: W1 g	
5	Specific Gravity: W4 / [W1 (W2 W3)]	
6	Apparent Specific Gravity:	

	W4 / [W4 (W2 W3)]	
7	Water Absorption: [(W1 W4) / W4] x 100	

Results:

Bulk Specific Gravity =

Apparent Specific Gravity =

Water Absorption (in %) =

Specifications: The specific gravity of aggregates normally used in road construction ranges from about 2.5 to 3.0 with an average value of about 2.68. Water absorption value ranges from 0.1% to about 2.0% for aggregates normally use in road surfacing. For good quality aggregates this value should not exceed 0.6% .

Applications: Specific gravity of aggregates is considered as an indication of strength. Material having higher specific gravity is generally considered as having higher strength. Water absorption of aggregate is a measure of porosity. This value is considered as a measure of resistance to frost action, and as a measure of sustaining weathering action.

2. Determination of particle size distribution.

Aim: Determination of particle size distribution of given aggregate sample.

Theory: Grain size analysis also known as mechanical analysis of particle is the determination of the percent of individual grain sizes present in the sample. The results of the test are of great value in soil classification. In mechanical stabilization of soil and for designing soil-aggregate mixtures the results of gradation tests are used. Correlations have also been made between the grain size distribution of soil and the general soil behaviour as a sub-grade material and the performance such as susceptibility to frost action, pumping of rigid pavements etc. Also permeability characteristics, bearing capacity and some other properties, are approximately estimated based on grain size distribution of the soil. The soil is generally divided into four parts based on the particle size. The fraction of soil, which is large than 2.00mm size, is called gravel that between 2.00 and 0.06 mm is sand, between 0.06 and 0.002 mm is silt and that which is smaller than 0.002 mm size is clay. Two types of sieves are available, one type with square perforations on plates to sieve coarse aggregates and gravel, the other type being mesh sieves made of woven wire mesh to sieve finer particles such as fine aggregates and soil fraction consisting of sand silt and clay. However the IS sieves range from 100 mm to 0.075 mm. Soil particles consisting of silt and clay, which are smaller than 0.06 mm size, will pass through the fine mesh sieve with 0.075 mm opening. Therefore the grain size analysis of the coarser fraction of soil (aggregate, sand) is carried out using sieves and that of finer fraction passing 0.075 mm sieve is carried out using the principle of sedimentation in water.

Apparatus: Various apparatus include set of standard sieve of different sieve sizes, balance, collector pan, oven.

Procedure

1. Take and weight sufficient quantity of the dry soil retained on 2.0 mm sieve. The quantity of taken may be increased when the maximum size of particles is higher.

2. Separate the sample in to the fractions by sieving through the set of sieves of sizes 80, 63, 20, 6, 3, 4.75 mm IS sieves. Additional sieve size may also be introduced if necessary.

3. After initial sieving, collect and weight the material retained on each sieve.

Observation and Calculation

Grain size analysis: Sieve Analysis

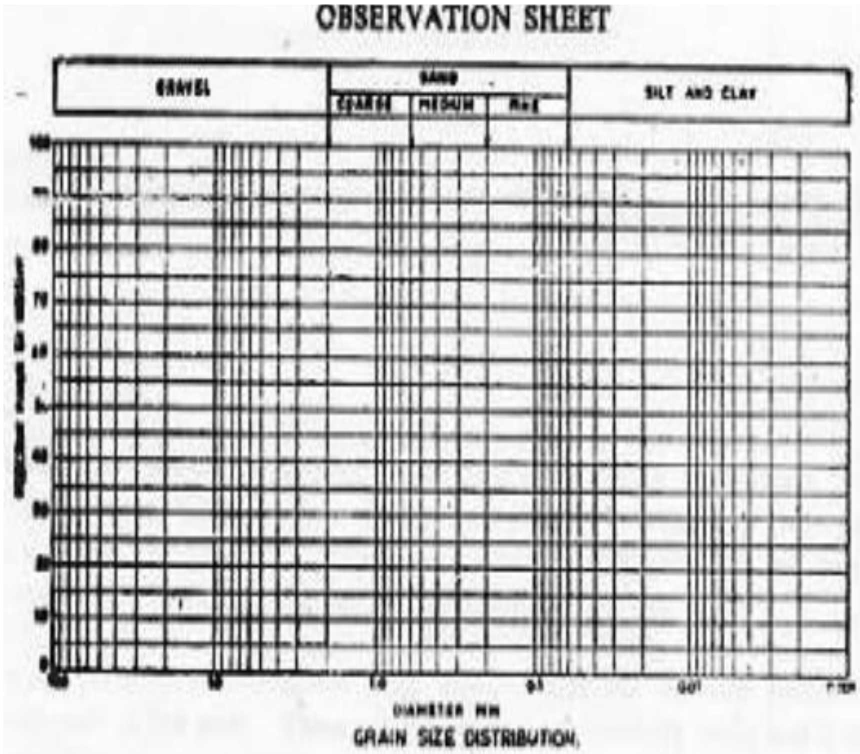
Description of particle : Aggregate / Sand

IS sieve upper & lower limits used: Total mass of particle sample, g =

Sieve opening	Mass of sieve or dish, g	Mass of sieve + dry soil, g	Mass of particle retained, g	Cumulative weight retained, g	Cumulative % retained	% Finer

80 mm 63 mm . . Pan						

Report on grain size distribution from the diagram (Figure 2.1)



grain Size Distribution Diagram

D_{10} = D_{30} = D_{60} =

Coefficient of Uniformity = $C_u = D_{60}/ D_{10}$

Coefficient of concavity = C_c =

where D_{10}, D_{30} and D_{60} are particle size corresponding to 10, 30 and 60 % finer.

Results: The results are plotted on a semi-logarithmic graph paper with the grain size or sieve size on the X axis in log scale and the percentage finer than each size on the y-axis in ordinary scale (Fig 2.1). The smooth curve joining the points thus obtained is known as the particle size distribution curve

Applications: The grin size distribution curve gives the exact idea regarding the gradation of the particles. It is possible to identify whether a soil is well graded, uniformly graded, or poorly graded. C_u and C_c are also useful to indicate the gradation.

Determination of aggregate impact value.

Aim: Determination of aggregate impact value of given aggreagate.

Theory: Toughness is the property of a material to resist impact. Due to traffic loads, the road stores are subjected to the pounding action or impact and there is possibility of stones breaking into smaller-. The road stones should therefore be tough enough to resist fracture under impact. A test designed evaluate the toughness of stones i.e., the resistance of the stones to fracture under repeated impacts may be called an impact test for road stones. Impact test may either be carried out on cylindrical stone specimens as in Page impact test or on stone aggregates as in Aggregate impact test. The page impact test is not carried out now a days and has been omitted from the revised British Standards for testing mineral aggregates. The aggregate impact it has been standardised by the British standard institution and the Indian standard institution. The aggregate impact value indicates a relative measuere of the resistance of aggregate a sudden shock or an impact which in some aggregates differs from its resistance to a slow compressive load. The method of test covers the procedure for determining the aggregate impact value of coarse aggregates.

Apparatus: The apparatus consists of an impact testing machine, a cylindrical measure tamping rod, IS sieve balance and oven.

(a) **Impact testing machine**: The machine consists of a metal base with a plane lower surface superior well on a firm floor, without rocking. A deteachable cylindrical steel cup of internal diameter 10.2cm and depth 5 cm is rigidly fastened centrally to the base plate. A metal hammer of weight between 13.5 and 140 kg having the lower end cylindrical in shape, 10 cm in diameter and 5 cm long, with 2 mm chamber at the lower edge is capable of sliding freely between vertical guides, and fall concentric over the cm. There is an arrangement for raising the hammer and allowing it to fall freely between vertical guides from a height of 38 cm on the test sample in the cup, the height of fall being adjustable upto 0.5 cm. A key is provided for supporting the hammer while fastening or removing the cup. Refer Figure 12.1.

(b) **Measure**: A cylindrical metal measure having internal diameter 7.5 cm and depth 5 cm for measuring aggregate.

(c) **Tamping rod**: A straight metal tamping rod of circular cross section, 1 cm in diameter and 23 cm long, rounded at one end.

(d) **Sieve**: IS sieve of sizes 12.5 mm, 10 mm and 2.36 mm for sieving the aggregates.

(e) **Balance**: A balance of capacity not less than 500 g to weigh accurate upto 0.1 g.

(f) **Oven**: A thermostatically controlled drying oven capable of maintaining constant temperature between 100^0C and 110^0C.

Procedure: The test sample consists of aggregates passing 12.5 mm sieve and retained on 10 mm sieve and dried in an oven for four hours at a temperature 100^0C to 110^0C and cooled.

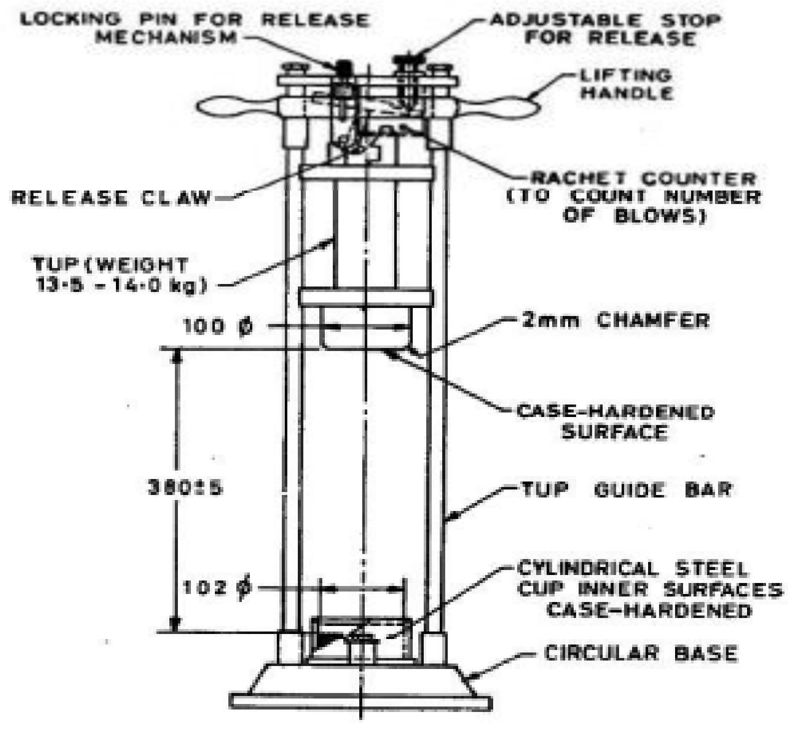


Figure 3.1 Impact testing machine

The aggregates are filled upto about one-third full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod. Further quantity of aggregates is then added upto about two-third ful in the cylinder and 25 strokes of the tamping rod are given. The measure is now filled with the aggregates to over flow, tamped 25 times. The surplus aggregates are struck off using the tamping rod as straight edge. The net weight of the aggregates in the measure is determined to the nearest gram and this weight of the aggregates is used for carrying out duplicate test on the same material. The impact machine is placed with its bottom plate fiat on the floor so that the hammer guide columns are vertical. The cup is fixed firmly in position on th base of the machine and the whole of the test sample from the cylindrical measure is transferred to the cup and compacted by tamping with 25 strokes. The hammer is raised until its lower face is 38 cm above the upper surface of the aggregates in the cup, and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows, each being delivered at an interval of not less than one second. The crushed aggregate is then removed from the cup and the whole of it sieved on the 2.36 mm sieve until no further significant amount passes. The fraction passing the sieve is weighed accurate to 0.1 g. The fraction retained on the sieve is also weighed and if the total weight of the fractions passing and retained on the sieve is added, it should not be less than the original weight of the specimen by more than one gram; if the total weight is less than the original by over one gram, the result should be discarded and a fresh test made. The above test is repeated on fresh aggregate sample.

Calculation

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

Let the original weight of the oven dry sample be W_1 g and the weight of fraction passing 2.36 mm IS sieve be W_2 g.

Aggregate impact value =. (100W2)/W1 percent

This is recorded correct to the first decimal place

Results The mean of the two results is reported as the aggregate impact value of the specimen to the nearest whole number. Aggregate impact value is to classify the stones in respect of their toughness property as indicated below :

Aggregate impact values

<10%   Exceptionally strong :

10-20%   Strong

10-30%   Satisfactorily for road surfacing ;

>35%   Weak for road surfacing

Discussion: Chief advantage of aggregate impact test is that test equipment and the test procedure are quite simple and it determines the resistance to impact of stones simulating field condition. The test can be performed in a short time even at construction site or at stone quarry, as the apparatus is simple and portable. Well-shaped cubical stones provide higher resistance to impact when compared with flaky and elongated stones. It is essential that the first specimen to be tested from each sample of aggregate is equal in volume; this is ensured by taking the specimen in the measuring cylinder in the specified manner by tamping in three layers. If all the test specimens to be tested in the aggregate impact testing mould are of equal volume, the height of these specimens will also be equal and hence the height of fall of the impact rammer on the specimens will be equal. On the other hand, if equal weight of different aggregate samples are taken, their volume and height may vary depending upon the specific gravity of the aggregates and their shape factors. There is no definite reason why the specified rate of application of the blows of the impact rammer should be maintained.

Applications of Aggregate Impact Value: The aggregate impact test is considered to be an important test to assess the suitability of aggregates as regards the toughness for use in pavement construction. It has been found that for majority of aggregate, the aggregate crushing and aggregate impact values are numerically similar within close limits. But in the case of fine grained highly siliceous aggregate which are less resistant to impact than to crushing the aggregate impact values are higher (on the average, by about 5) than the aggregate crushing values. Various agencies have specified the maximum permissible aggregate impact values for the different types of pavements, those recommended by the Indian Roads congress are given in Table 3.1.

For deciding the suitability of soft aggregates in base course construction, this test has been commonly used. 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. The recommendations given in Table 3.2 based on work reported by different agencies; have been made to assess the suitability of soft aggregate for road construction.

TABLE 3.1

Maximum Allowable Impact Value of Aggregate in Different Types of Pavement Material/Layers

Serial No.	Types of pavement material/layer	Aggregate impact value, maximum,%
1	Water bound macadam (WBM), sub base course	50
2	Cement concrete, base course (as per ISI)	45
3	(i) WBM base course with bitumen	40

	surfacing (ii) Built up-spray grout, base course	
4	Bituminous macadam, base course	35
5	(i) WBM, surfacing course (ii) Built-up spray grout, surfacing course (iii) Bituminous penetration macadam (iv) Bituminous macadam, binder course (v) Bituminous surface dressing (vi) Bituminous carpet (vii) Bituminous/Asphltic concrete (viii) Cement concrete, surface course	30

TABLE 3.2

Condition of Sample	Maximum aggregate impact Value, percent	
	Sub-base and base	Surface course
Dry	50	32
Wet	60	39

4. Determination of aggregate crushing value.

Aim: Determination of aggregate crushing value of given sample.

Theory: The principal mechanical properties required in road stones are (i) satisfactory resistance to crushing under the roller during construction and (ii) adequate resistance to surface abrasion under traffic. Also surface stresses under rigid tyre rimes of heavily loaded animal drawn vehicles are high enough to consider the crushing strength of road aggregates as an essential requirement in India. Crushing strength of road stones may be determined either on aggregates or on cylindrical specimens cut out of rocks. These two tests are quite different in not only the approach but also in the expression of the results. Aggregates used in road construction, should be strong enough to resist crushing under traffic wheel loads. If the aggregates are weak, the stability of the pavement structure is likely to be adversely affected. The strength of coarse aggregates is assessed by aggregates crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement. Aggregate possessing low aggregate crushing value should be preferred.

Apparatus: The apparatus for the standard aggregate crushing test (Figure 10.1)consists of the following :

(i) Steel cylinder with open ends, and internal diameter 25.2 cm, square base plate plunger having a piston of diameter 15 cm, with a hole provided across the stem of the plunger so that a rod could be inserted for lifting or placing the plunger in the cylinder.

(ii) Cylindrical measure having internal diameter of 11.5 cm and height 18 cm.

(iii) Steel temping rod with one rounded end, having a diameter of 1.6 cm and length 45 to 60 cm

(iv) Balance of capacity 3 kg with accuracy upto 1 g.

(v) Compressions testing machine capable of applying load of 40 tonnes, at a uniform rate of loading of 4 tonnes per minute.

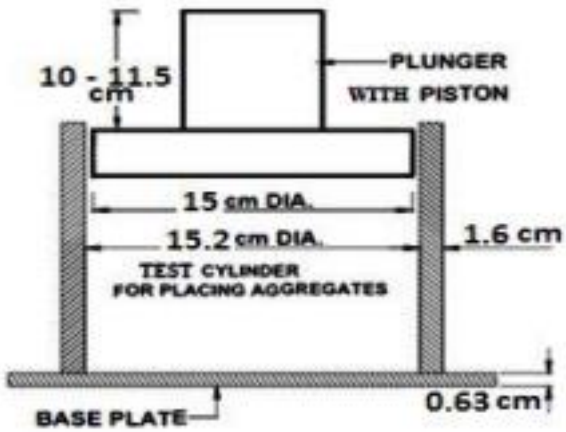


Figure 4.1 Crushing test apparatus

Procedure: The aggregate passing 12.5 mm sieve and retained on 10 mm IS sieve is selected for standard test. The aggregate should be in surface-dry condition before testing. The aggregate may be dried by heating at a temperature 100^0C to 110^0C for a period of 4 hours and is tested after being cooled to room temperature. The cylindrical measure is filled by the test sample of aggregate in three layers of approximately equal depth, each layer being tamped 25 times by the rounded end of the tamping rod. After the third layer is tamped, using the tamping rod as a straight edge levels off the aggregate at the top of the cylindrical measure. About 6.5 kg of aggregate is required for preparing two test samples. The test sample thus taken is then weighed. The same weight of the sample is taken in the repeat test. The cylinder of the test of the test apparatus is placed in position on the base plate;

one third of the test sample is placed in the cylinder and tamped 25 times by the tamping rod. Similarly, the other two parts of the test specimen are added, each layer being subjected to 25 blows. The total depth of the material in the cylinder after tamping shall however be 10cm. The surface of the aggregates is leveled and the plunger inserted so that it rests on this surface in level position. The cylinder with the test sample and plunge 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 then the load is released. Aggregates including the crushed portion are removed from the cylinder and sieved on a 2.36 mm IS sieve. The material which passes this sieve is collected. The above crushing test is repeated on second sample of the same weight in accordance with above test procedure. Thus two tests are made for the same specimen for taking an average value.

Calculation: Total weight of dry sample taken = W1 g. Weight of the portion of crushed material passing 2.36 mm IS sieve = W2 g.

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

Aggregate crushing value = (100 W2 / W1)

Results: The mean of the crushing value obtained in the two tests is reported as the aggregate crushing value.

Determination of Ten Percent Fines Value:

aggregates to the crushing. The apparatus and materials used are the same as for the standard aggregate crushing test. The test sample in the cylinder with the plunger in position is placed in the compression testing machine. The load is applied at a uniform rate so as to cause a total penetration of the plunger of about 20 mm for normal crushed aggregates in 10 minutes. But for rounded or partially rounded aggregates, the load required to cause a total penetration of 15 mm is applied where as for honey combed aggregate like expanded shales or slags that for a total penetration of 24 mm is applied in 10 minutes. After the maximum specified penetration is reached, the load is released and the aggregates from the cylinder is sieved on a 2.36 mm IS sieve. The fines passing this sieve is weighed and is expressed as a percentage by weight of the test sample. This percentage normally falls in the range of 7.5 to 12.5; but if it does not fall in this range, the test is repeated with necessary adjustment of the load. Two tests are carried out at the load (tones) which give the percentage fines between 7.5 and 12.5 and let the alculating the load required for 10 percent fines.

$$\text{load for 10 percent fine} = \frac{14x}{(y + 4)}$$

Discussion: In general, large size of aggregates used in the test results in higher aggregates crushing value. The relationship between the aggregate sizes and the crushing values will however vary with the type of specimens tested. When non-standard sizes of aggregates are used for the crushing test, (i.e. aggregate larger than 12.5 mm or smaller than 10 mm) the size of the cylinder, quantity of material for preparation of specimen size of IS sieve for separating fines and the amount and rate of compaction shall be adopted as given in Table 4.1.

TABLE 4.1

Details for Aggregate Crushing Test with Non-standard Sizes of Aggregate

Aggregate size		Diameter of cylinder to be used, cm	Quantity of material and preparation of test sample	Loading	Size of IS is sieve for separating fines
Passive sieve size, mm	Retained on Sieve size,mm				
25	20	15 (standard cylinder)	** Standard method	Standard loading	mm 3.35 mm
20	12.5		Standard method	Standard loading	1.70 mm
10	6.3	7.5	metal measure 5 cm dia & 9 cm height tamping Rod 8mm dia 30 cm long Depth of material in 7.5 Cm cylinder after tamping 5 cm	Rate of loading one tonne per min. upto A total load of 10 Tones	
6.3	4.75				1.18 mm
4.75	3.35	7.5	As above	As above	850 microns
3.35	2.36	7.5	As above	As above	600 microns
		7.5	As above	As above	

* Standard cylinder as given in Figure 4.1.

* Standard method of preparing sample as given in procedure.

* Standard loading as given in procedure.

The aggregate sample for conducting the aggregate crushing test for the first time is to be taken by volume in the specified cylindrical measure by tamping in a specified manner and the weight of the sample is determined. When the test is repeated using the same aggregate, it is sufficient to directly weigh and take the same weight of sample. This is because it is necessary to keep the volume and height of the test specimens in the aggregate crushing mould constant when testing any aggregate sample so that the test, conditions remain unaltered. If the quantity of test sample to be taken is specified by weight, the volume and hence the height may vary depending on the variation in specific gravity and shape factors factors of different aggregates. When aggregates are not available, crushing strength test may be carried out on cylindrical specimen prepared out of rock sample by drilling, sawing and grinding. The specimen may be subjected to a slowly increasing compressive load until failure to find the crushing strength in kg/cm2. However, this test is seldom carried out due to difficulty in preparing specimens and not getting reproducible results. On the contrary, the aggregate crushing test is simple, rapid and gives fairly consistent results.

Applications of Aggregate Crushing Test: The aggregate crushing value is an indirect measure of crushing strength of the aggregates. Low aggregate crushing value indicates strong aggregates, as the crushed fraction is low. Thus the test can be used to assess the suitability of aggregates with reference to the crushing strength for various types of pavement components. The aggregates used for the surface course of pavement should be strong enough to withstand the high stresses due to wheel loads, including the steel types of loaded bullock-carts. However as the stresses at the base and sub-base courses are low aggregates with letter crushing strength may be used at the lower layers of the pavement.

Indian Roads Congress and ISI have specified that the aggregate crushing value of the coarse aggregate used for cement concrete pavement at surface should not exceed 30 percent. For aggregate used for concrete other than for wearing surfaces, the aggregate crushing value shall be exceed 45 percent, according to the ISS. However aggregate crushing values have not been specified the IRC for coarse aggregates to be used in bituminous pavement construction methods.

Determination of Los Angeles abrasion value of aggregates.

Aim: Determination of Los Angeles abrasion value of given aggregate sample.

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

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

(i) Los Angeles abrasion test

(ii) Deval abrasion test

(iii) Dorry abrasion test

Los Angeles Abrasion Test:

the Los Angeles abrasion test is more commonly adopted as the test values of aggregates have been correlated with performance of studies. The ISI has suggested that wherever possible, Los Angeles abrasion test should be preferred. In addition to the above abrasion tests, another test which is carried out to test in a machine and a friction test is carried out on the polished specimen. The results of this test are useful only for comparative purpose and specifications are not yet available. The 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. Some investigators believe this test to be more dependable as rubbing and pounding action simulate the field conditions where both abrasion and impact occur. Los Angeles abrasion test has been standardized by the ASTM, AASHO and also by the ISI. Standard specification of Los Angeles abrasion values are also available for various types of pavement constructions.

Apparatus: The apparatus consists of Los Angeles machine and sieves.

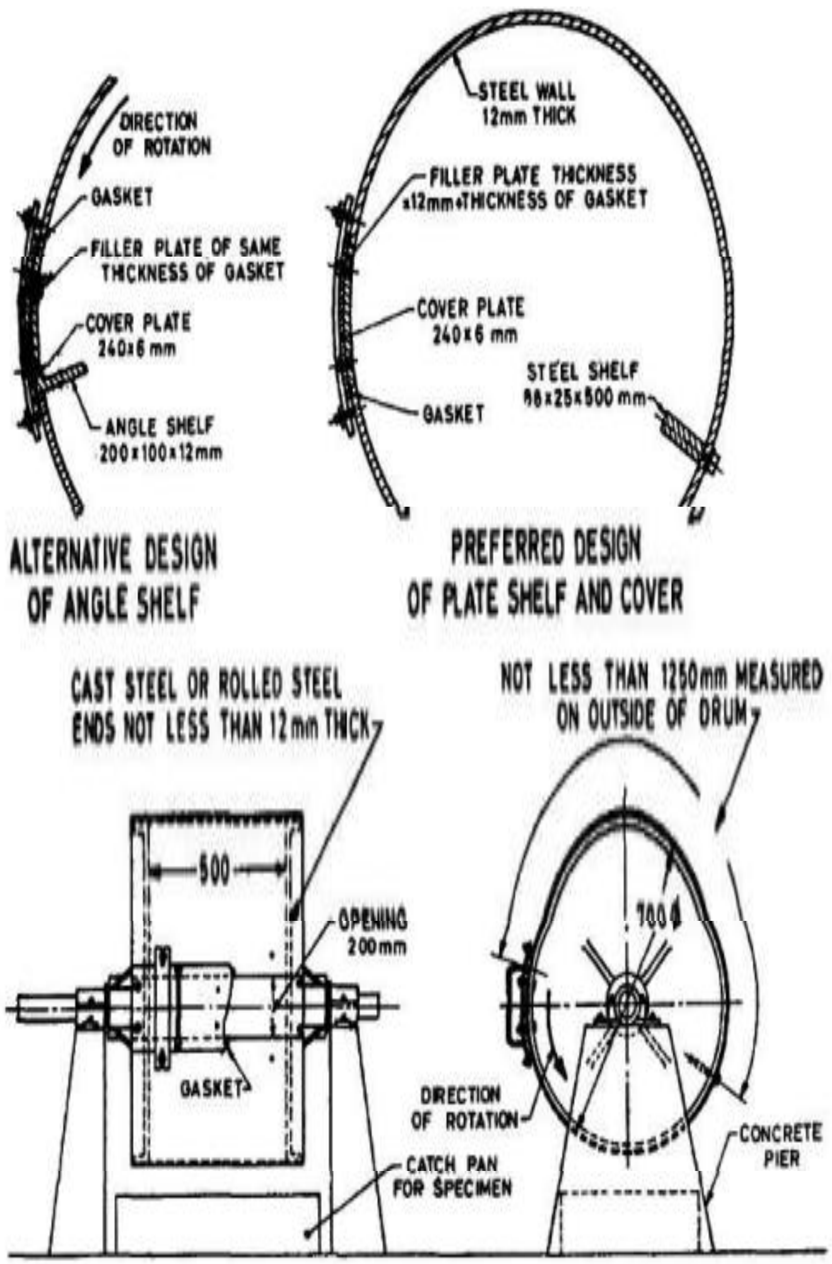
Los Angeles machine consists of a hollow steel cylinder, closed at both ends, having an inside diameter 70 cm and an inside length of 50 cm, mounted on stub shafts about which it rotates on a horizontal axis. An opening is provided in the cylinder for the introduction of the test sample. A removable cover of the opening is provided in such a way that when closed and fixed by bolts and nut, it is dust-tight and the interior surface is perfectly cylindrical. A removable steel shelf projecting radially 8.8 cm into the cylinder and extending to the full length of it, is mounted on the interior surface of the cylinder rigidly, parallel to the axis. The shelf is fixed at a distance of 125 cm from the opening, measured along the circumference in the direction of rotation refer Figure 5.1. Abrasive charge, consisting of cast iron spheres approximately 4.8 cm in diameter and 390 to 445 g in weight are used. The weight of the sphere used as the abrasive charge and the number of spheres to be used are specified depending on the graduation of the aggregates tested. The aggregate grading have been standardized as A,B,C, D, E, F, and G for this test and the IS specifications for the grading and abrasive charge to be used are given in Table 5.1. IS sieve with 1.70 mm opening is used for separating the fines after the abrasion test.

Procedure: Clean aggregates dried in an oven at 105-110^{0}C to constant weight, conforming to any one of the grading A to G, as per Table 5.1 is used for the test. The grading or gradings used in the test should be nearest to the grading to be used in the construction. Aggregates weighing 5 kg for grading A,B, C or D and 10 kg for 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 5.1 depending on the grading of the aggregate and is placed in the cylinder of the machine. The cover is then fixed dust-tight. The machine is rotated at a speed of 30 to33 revolutions per minute. The machine is rotated for 500 revolution for gradings A,B,C and D, for gradings E,F and G, it shall be rotated for 1,000 revolutions. The machine should be balanced and driven in such a way as to maintain uniform peripheral speed. After the desired number of revolutions, the machine is stopped and the material is discharged from the machine taking care to take out entire stone dust. Using a sieve of size larger than 1.70 mm IS sieve, the materials is first separated into two parts and the finer position is taken out and sieved further on a 1.7 mm IS sieve. The portion of material coarser than 1.7 mm size is washed and dried in an oven at 105 to 110^{0}C to constant weight and weighed correct to one gram.

TABLE 5.1: Specifications for Los Angeles Test

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**	**Number of Spheres**	**Weight of Charge ,g**
1	-	-	-	1250	1250	1250	1250	-	-	-	12	5000 25
	-	-	-	-	-	2500	2500	-	-	-	11	4584 25
	-	-	-	-	-	-	-	2500	2500	-	8	3330 20
	-	-	-	-	-	-	-	-	-	5000	6	2500 5
	2500*	2500*	5000*	-	-	-	-	-	-	-	12	5000 25
	-	-	5000*	5000*	-	-	-	-	-	-	12	5000 25
	-	-	-	5000*	5000*	-	-	-	-	-	12	5000 25

*Tolerance of 2 percent is permitted.



NOTE 1 — Shaft bearing will be mounted on concrete piers or other rigid supports.

NOTE 2 — Suggested horse power for motor is not less than one.

All dimensions are in mm

Figure 5.1 : Los Angeles Abrasion Machine

Calculations: The difference between the original and final weights of the sample is expressed as a percentage of the original weight of the sample is reported as the percentage wear. Let the original weight of aggregate = W_1g

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

Loss in weight due to wear = (W_1-W_2)g

Los Angels abrasion Value, % = Percentage wear = $(W_1-W_2) / W_1$ *100

Result : The result of the Los Angeles abrasion test is expressed as a percentage wear and the percentage value of two test may be adopted as the Los Angeles abrasion value.

Discussion : It may seldom happen that the aggregates desired for a certain construction project has the same grading as any one of the specified gradings. In all the cases, standard grading or grading nearest to the gradation of the selected aggregates may be chosen. Different specification limits may be required for gradings E, F an G, when compared with A, B, C and D. Further investigations are necessary before any such specifications could be made. Los Angeles abrasion test is very commonly used to evaluate the quality of aggregates for use in pavement construction, especially to decide the hardness of stones. The allowable limits of Los Angeles abrasion values have been specified by different agencies based on extensive performance studies in the field. The ISI has also suggested that this test should be preferred wherever possible. However, this test may be considered as one in which resistance to both abrasion and impact of aggregate may be obtained simultaneousy, due to the presence of abrasive charge. Also the test condition is considered more representative of field conditions. The result obtained on stone aggregates are highly reproducible.

Application of Los Angeles Abrasion Test: Los Angeles Abrasion test is very widely accepted as a suitable test to assess the hardness of aggregates used in pavement construction. Many agencies have specified the desirable limits of the test, for different methods of pavement construction. The maximum allowable Los Angeles abrasion values of aggregates as specified by Indian roads congress for different methods of construction are given in Table 5.2.

TABLE 5.2: Max. Allowable Los Angeles Abrasion Values of Aggregates in Different of Pavement Layers

Serial no.	Types of pavement layer	Loss Angeles Abrassion value, Max.
1	Water Bound macadam (WBM), sub-base course	60
2	.(i) WBM base course with bituminous surfacing (ii) Bituminous Macadam base course (iii) Built-up spray grout base course	50
3	(i) WBM surfacing course (ii) Bituminous Macadam binder course 40 (iii) Bituminous penetration macadam (iv) Buil-up spray grout	40

	binder course	
4	(i) Bituminous carpet surface course (ii) Bituminous surface dressing, single or two coats (iii) Bituminous surface dressing, using precoated aggregates 35 (iv) Cement concrete surface course (as per IRC)	35
5	(i) Bituminous/Asphaltic concrete surface course (ii) Cement concrete pavement surface course (as per ISI)	30

Determination of flakiness index and elongation index of coarse aggregate.

Aim: To determine flakiness index and elongation index of coarse aggregate.

Theory: The particle shape of aggregate is determined by the percentage of flaky and elongated particles contained in it. In 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 workability of concrete improves. Angular shape of particles is desirable for granular base course 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 voids content in an aggregate of any specified size increases and hence the grain size distribution of a grade aggregate has to be suitably altered in order to obtain minimum voids in the dry mix or the highest dry density. The angularity number denotes the void content 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. Thus evaluation of shape of the particles, particularity with reference to flakiness, elongation and angularity is necessary. The flakiness index of aggregate is the percentage dry 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 The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and four fifth (1.8 times) of their mean dimension. The elongation test is not applicable to sizes smaller than 6.3 mm.

Determination of flakiness index.

Apparatus: The apparatus consists of a standard thickness gauge shown in fig 6.1, IS sieves of the sizes 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 mm and a balance to weight the samples.

PROCEDURE: A minimum of 200 pieces of each fraction of aggregate size to be tested are taken and weighed =W1g. in order to separate flaky materials, each friction is then gauged for thickness on a thickness gauge shown in fig 6.1 or in bulk on sieves having elongated slots. The amount of flaky material passing the gauge is weighed to accuracy of at least 0.1 percent of the test sample.

Observations and Calculations: In order to calculate the flakiness index of the entire sample of aggregates first the weight of each fraction of aggregates passing and retained on the specified set of sieves is noted. As an example let 200 pieces of the aggregates passing 50 mm sieve and retained on 40 mm sieve be = W1g. Each of the particles from this fraction of the thickness gauge in this example the width of the appropriate gauge of the thickness gauge is = [(50+40)/2] * 0.6 = 27mm

Let the weight of the flaky material passing this gauge be = X1g. Similarly the weights of the fractions passing and retained the specified sieves W1, W2, W3 etc weighted and the total weight = W1 + W2 + W3 +... = W g is found. Also the weights of material passing each of the specified thickness gauges are found = X1, X2, X3 etc and the total weight of the material passing the different thickness gauges = X1 + X2 + X = X g.

.... Total = W = X =

Flakiness index = (X/ W) 100 =

Result: Flakiness index of the given aggregate =

B. Determination of flakiness index.

Apparatus: The apparatus length gauge consists of the Standard length gauge as shown in fig. 6.2 IS sieve of size 50, 40, 25, 20, 16, 12.5, 10 and 6.3 mm .A balance to weigh the samples.

Procedure: The sample is sieved through the specified set of IS sieves. A minimum of 200 pieces of each fraction is taken and weighed. In order to separate elongated material, each fraction is then gauged individually for length gauge. The gauge length used should be those specified in column 4 of the table for the appropriate material. The pieces of aggregates from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and are collected separately to find the total weight of aggregate retained by the length gauge are weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

Observations and Calculations: In order to calculate the elongation index of the entire sample of aggregates, the weight of aggregates which is retained on the specified gauge length from each fraction is noted. As an example, let 200 pieces of the aggregate passing 40 mm sieve and retained 25 mm sieve weight W1g. Each piece of these are tried to be passed through the specified gauge length of length gauge, which in this example is = [(5+25)/2] * 1.8 = 59.5 mm. With its longest side, those elongated pieces which do not pass the gauge are separated and the total weight determined=Y1g. Similarly the weight of each fraction of aggregate passing and retained on specified sieves sizes are found = W1, W2, W3, etc and the total weight of sample determined = W1 + W2 + W g. Also the weight of material from each fraction retained determined on the specified gauge length are found = Y1, Y2, Y3, etc and total weight retained determined = Y1 + Y2 + Y3 + Y g. Total = W = Y = Elongation index = (Y/W) 100 =

Result: Elongation index of the given aggregate =

Specification: Generally the index values should not exceed 15 % for aggregates to be suitable for construction.

Determination of penetration value of bitumen.

Aim: To determine penetration value of bitumen.

Theory: The penetration test is widely used world over for classifying the bitumen into different grade. The ISI has standardized the penetration test equipment and the procedure, Figure 7.1. Even though is recognized that the empirical tests like penetration, softening point etc. can not fully qualify the binder for its temperature susceptibility characteristic, the simplicity and quickness of operation of the test can not be ignored for common use.

Apparatus: It consists of items like container, needle, water bath penetrometer, stop watch etc. Following are the standard specifications as per ISI for the above apparatus.

(a) Container : A flat bottomed cylindrical metallic container 55 mm in diameter and 35mmor 57 mm in height.

(b) Needle : A straight, highly polished cylindrical hard steel needle with conical end, having the shape and dimensions. The needle is provided with a shank approximately 3.0 mm in diameter into which it is immovably fixed.

(c) Water-bath : A water bath is maintained at 25 1^{0}C containing not less than 10 litres of water, the sample is immersed to depth not les than 100 mm from the top and supported on a perforated shelf not less than 50 mm from the bottom of the bath.

(d) Penetrometer : It is an apparatus which allows the needle assembly of gross weight 100 g to penetrate without appreciable friction for the desired duration of time. The dial is accurately calibrated to give penetration value in units of one tenth of a mm. Electrically operated automatic penetrometers are also available.

(e) Transfer tray : A small tray which can keep the container fully immersed in water during the test.

Procedure: The bitumen is softened to a pouring consistency between 75^0 and 100^0C above the approximate temperature at which bitumen softens. The sample material is thoroughly stirred to make it homogenous & free form air bubbles & water. The sample material is then poured into the container to a depth at least 15 mm more than the expected penetration. The sample containers are cooled in atmosphere of temperature not lower than 13^0C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25^0C for a period of one hour. The sample container is placed in the transfer tray with water from the water bath and placed under the needle of the penetrometer. The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100 g. using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample; the needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle. The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is taken before releasing the needle. The needle is released exactly for a period of 5.0 secs by pressing the knob and the final reading is taken on the dial. At least three measurements are made on this sample by testing at distance of not less than 100 mm apart. After each test the needle is disengaged and cleaned with benzene and carefully dried. The sample container is also transferred in the water bath before next testing is done so as to maintain a constant temperature of 25^0C. The test is repeated with sample in the other containers.

Observations:

Reading	Sample No.				Sample No.			
	Test 1	Test 2	Test 3	Mean value	Test 1	Test 2	Test 3	Mean value
1) Penetrometer dial reading (i) initial (ii) final 2) Penetration value (in division)								

Mean penetration value =

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

The mean penetration value should not differ by more than the amount given below:

Penetration	**Maximum Difference**
0 to 49	2
50 to 149	4
150 to 249	6
250 and above	8

Discussion: It may be noted that the penetration value is influenced by any inaccuracy as regards : (i) povring temperature

(ii) size of needle

(iii) weight placed on the needle

(iv) test temperature

(v) duration of releasing the penetration needle

It is obvious to obtain high values of penetration if the test temperature an /or weight (place over the needle) are/is increased. Higher pouring temperature than that specified may result in hardening of bitumen and may give lower penetration values. Higher test temperatures give considerably higher penetration values. The duration of releasing the penetration needle be exactly 5.0 secs. It is also necessary to keep the needle clean before testing in order to get consistant results. The penetration needle should not be placed closer than 10 mm from the side of the dish.

Applications of Penetration Test

Penetration test is the most commonly adopted test on bitumen to grade the material in terms of its hardness. Depending upon the climatic condition and type of construction, bitumens of different penetration grades are used, 80/100 bitumen denotes that the penetration value ranges between 80 and 100. The penetration value of various types of bitumen used in pavement construction in this country range between 20 and 225. For bituminous macadam and penetration macadam IRC suggests bitumen grades 30/40, 60/70 & 80/100. In warmer regions lower penetration grades are preferred and in colder regions bitumen with higher penetration values are used.

Determination of softening point value of bitumen.

Aim: To determine softening point of a given bitumen sample.

Theory: Bitumen does not suddenly change from solid to liquid state ,but as the temperature increases it gradually becomes softer until it flows readily .A semi solid state bitumen grades need sufficient fluidity before they are used for application with the aggregate mix .For this purpose bitumen is sometimes cut back with a solvent like kerosene .The common procedure however is to liquefy the bitumen by heating .The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test . For bitumen it usually determined by Ring and Ball test. Brass ring test containing the test sample of bitumen is suspended in liquid like water or glycerin at a given temperature. A steel ball is placed upon the bitumen and liquid medium is then heated at a specified distance below the ring is recorded as the softening point of a particular bitumen. The apparatus and test procedure are standardized by ISI. It obvious but harder grade bitumen posses higher softening point than softer grade bitumen. The concept of determining the softening point by Ring and Ball apparatus is shown fig8.1

APPARATUS: It consists of Ring and Ball apparatus

(i) Steel Balls they are two in number. Each as a diameter of 9.5 mm and weight 2.5 to 5 g.
(ii) Brass rings are placed with ball guides. Brass Rings there are two rings of the following dimensions.

Depth 6.4 mm

Inside diameter at top 17.5 mm

Inside diameter at bottom 15.9 mm

Outside diameter 20.6 mm

(iii)Support the metallic support is used for placing pair of rings.

(iv)Bath and Stirrer: A heat resistance glass container of 85mm dia and 120mm materials having softening point above 80 degree C and glycerin for materials having softening point above 80 degree C. Mechanical stirrer is used for ensuring uniform distribution all times through out the bath. The upper surface of the rings is adjusted to be 50mm below the surface of the water or liquid contained in the bath. A distance the bottom of the rings on top surface of the bottom plate of support is provided it has a housing for a suitable thermometer.

Procedure: Sample material is heated to a temperature between 75 and 100–C above the approximate softening point until it is fluid and is poured in heated rings placed on 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 as discussed in item above .At this time the temperature of distilled water is kept at 5-C. This temperature is maintained for 15 minutes after which the balls are placed in position. The temperature of water is raised at uniform rate of 5-C per minute with a controlled heating unit 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–C, glycerin is used as a heating medium and the starting temperature is 35 C, instead of 5 C.

Observations: Sample No. :

Softening point value :

Result: The softening point of given bitumen sample =

Discussion:

As in the other physical tests on bitumen it is essential that the specifications discussed above are strictly observed. Particularly, any variation in the following point would effect the result considerably

1) Quality and type of liquid

2) Weight of balls

3) Distance between bottom of ring and bottom base plate

4) Rate of heating

Impurity in water or glycerine has been observed to effect the result considerably. It is logical to observe lower softening point if there weight of ball is excessive on the other hand increased distance between bottom of ring and bottom of plate increases the softening point.

Determination of ductility value of bitumen.

Aim: To determine ductility value of bitumen.

Theory: In the flexible pavement construction where bitumen binders are used, it is of significant that the binders form ductile thin films around the aggregates. This serves as satisfactory improving the physical interlocking of the aggregates. The binder material which does not posses ductility would crack and thus provide pervious pavement surface. Thus in turn results in damage to the pavement structure. It has been stated by some agencies that the penetration and properties, go together; but depending upon the chemical composition and the type of bitumens, sometimes it has been observed that the above statement is incorrect. It may hence be that the bitumen may satisfy the penetration value, but may fail to satisfy the ductility Bitumen paving engineer would however want that both test requirements are satisfied in the Penetration or ductility can not in any case replace each other. The ductility is expressed as the in centimeters to which a standard briquette of bitumen can be stretched before the thread test is conducted at 27 0.5^{0}C and a rate of pull of 50 2.5 mm per minute. The test standardized by the ISI.

Apparatus: The ductility test apparatus consists of items like sample (briquette) moulds, water, trowel or putty knife sharpened on end and ductility machine. Standard specification .

(a) Briquette mould : Mould is made of bras metal with shape and dimeter as in fig 11.2 Bot ends called clips possess circular holes to grip the fixed and move machine. Side pieces when placed together form the briquette of the following dimensions.

Length	75 mm
Distance between clips	30 mm
Width at mouth of clips	20 mm
Cross section at minimum width	10 mm 10 mm

(b) Ductility machine : It is an equipment which functions as constant temperature water bath and a pulling device at a precalibrated rate. The central rod of the machine is threaded and through a gear system provides movement to one end where the clip is fixed during initial placement. The other clip end is hooked at the fixed end of the machine. Two clips are thus pulled apart horizontally at a uniform speed of 50 2.5 mm per minute. The machine may have provision to fix two or more mould so as to test these specimens simultaneously.

Procedure: The bitumen sample is melted to a temperature of 75^{0}C to 100^{0}C above the approximate softening point until it is fluid. It is strained through Is sieve 30, poured in the mould assembly and placed on a brass plate, after a solution of glycerine and dextrine is applied at all surfaces of the mould exposed to bitumen. Thirty to forty minutes after the sample is poured into the moulds, the plate assembly alongwith the sample is placed in water bath maintained at 27^{0}C for 30 minutes. The sample and mould assembly are removed from water bath and excess bitumen material is cut off by leveling the surface using hot knife. After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at 27^{0}C for 85 to 95 minutes. The sides of the mould are now removed and the clips are carefully booked on the machine without causing any initial strain. Two or more specimens may be prepared in the moulds and clipped to the machine so as to conduct these tests simultaneously. The pointer is set to read zero. The machine is started and the two clips are thus pulled apart horizontally. While the test is in operation, it is checked whether the sample is immersed in water at depth of at least 10 mm. The distance at which the bitumen thread of each specimen breaks, is recorded (in cm) to report as ductility value.

OBSERVATION SHEET DUCTILITY TEST

Test property	Briquette number			Mean Value
	I	II	III	
Ductility value (cm)				

Results: The ductility value of given bitumen sample =

Discussion : The ductility value gets seriously affected if any of the following factors are varied :

(i) pouring temperature .

(ii) dimensions of briquette

(iii) improper level of briquette placement

(iv) test temperature

(v) rate of pulling

Increase in minimum cross section of 10 sq, mm and increase in test temperature would record increased tactility value.

Applications of Ductility Test: A certain minimum ductility is necessary for a bitumen binder. This is because of the temperature changes in the bituminous mixes and the repeated deformations that occur in flexible pavements due to the traffic loads. If the bitumen has low ductility value, the bituminous pavement may crack, especially in cold weather. The ductility values of bitumen vary from 5 to over 100. Several agencies have specified the minimum ductility values for various types of bituminous pavement. Often a minimum ductility value of 50 cm is specified for bituminous construction.

References :

1. Indian Standard (IS) codes for various tests.

2. Highway Engineering by S. K. Khanna and CEG Justo.

B. TECH IV– YEAR (VII Sem)

SUBJECT: Road Material Testing Lab (7CE4-21)

(6CE4-23)

Viva

1. Explain Highway Engineering? ...
2. What Is The History Of Highway Engineering? ...
3. Explain About Ancient Roads? ...
4. Explain Roman Roads? ...
5. Explain French Roads? ...
6. Explain British Roads? ...
7. Explain Modern Roads? ...
8. Explain The Highway Planning In India?
9. What do you mean by elongation index of an aggregate?
10. What do you infer from elongation index.
11. How the elongation index of the sample helps in deciding the design of a highway.
12. What do you mean by flakiness index of an aggregate.
13. What do you infer from flakiness index.
14. How the flakiness index of the sample helps in deciding the design of a highway.
15. How is aggregate Impact expressed.
16. What do you understand by dry and wet Impact value.
17. Aggregate Impact value of material A is 15 and that of B is 35. Which one is better for surface course 10.
18. The abrasion value found from Los Angeles test for two aggregates A and B are 50% and 38% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?

B. TECH IV– YEAR (VII Sem)

SUBJECT: Road Material Testing Lab (7CE4-21)

(6CE4-23)

Quiz

1. The materials not included in highway construction are ___________

a) Stone

b) Dust

c) Soil

d) Petrol

(d)

2. For places where there is a passage of flood water then the highway has to be built on ___________

a) Embankment

b) Subway

c) Overpass

d) Underpass

(A)

3. The layer which is constructed above embankment is called ___________

a) Sub grade

b) Fill

c) Base

d) Sub base

(A)

4. The highest CBR number is required for ___________

a) Pavement

b) Sub grade

c) Sub base

d) Base

(B)

5. What is the most common waste material used in construction?

a) Fly ash

b) Slag

c) Pozzolona

d) Rice husk

(A)

6. Bitumen is a by-product of ___________

a) Wood

b) Petroleum

c) Kerosene

d) Coal

(B)

7. Tar is a by-product of ___________

a) Wood

b) Petroleum

c) Kerosene

d) Coal

(A)

8. In the initial stage of construction which type of pavement is cheap?

a) Flexible

b) Rigid

c) Composite

d) WBM

(A)

9 district road with a bituminous pavement has a horizontal curve of 1000 m for a design speed of 75 km ph. The super-elevation is

a)1 in 40

b)1 in 50

c)1 in 60

d)1 in 70

e) none of these.

(A)

10. The minimum value of camber provided for thin bituminous surface hill roads, is

A) 2.2%

b) 2.5%

C) 3.0%

D) 3.5%

(B)