LIST OF EXPERIMENTS

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EXPERIMENT NO - 1

Aim: To determine the Specific gravity of given Bituminous material.

Apparatus: There are two methods. 1) Pycnometer Method, 2) Balance Method. Pycnometer Method: Specific gravity Bottle, Balance and Distilled water.

Theory -
The density of a bitumen binder is a fundamental property frequently used as an aid in classifying the binders for use in paving jobs. In most applications, the bitumen is weighed, but finally in use with aggregate system, the bitumen content is converted on volume basis. Thus an accurate density value is required for conversion of weight to volume. The specific gravity is greatly influenced by the chemical composition of binder. Increased amount of aromatic type compounds cause an increase in the specific gravity.
The specific gravity is defined by ISI as the ratio of the mass of a given volume of the bituminous material to the mass of an equal volume of water, the temperature of both being specified at 27°C±0.1°C.
The code of practice used to determine the specific gravity is **IS: 1202**

Procedure:
The clean, dried specific gravity bottle is weighed let that be W_i gm.
> Then it is filled with fresh distilled water and then kept in water bath for at least half an hour at temperature 27°C±0.1°C.

> The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. Let this be W2gm.

> 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_3gm.

> The remaining space in specific gravity bottle is filled with distilled water at 27°C and is weighed. Let this be W_4gm. Then specific gravity of bituminous material is given by formula.

Detail	Sample 1	Sample 2	Mean value
Wt. of empty bottle (w_1) gm			
Wt. of bottle + aggregate (w_2) gm			
Wt. of bottle + aggregate + water (w_3) gm			
Wt. of bottle +water (w4) gm			

Specific gravity = $(W_1 - W_2) / (W_1 - W_2) - (W_3 - W_4)$
Result .....

EXPERIMENT NO - 2

THEORY-
The water absorption of coarse aggregates is determined as per IS: 2386 (Part III) – 1963. The apparatus used for this test are:-
Wire basket – perforated (electroplated or plastic coated with wire hangers for suspending it from the balance) (figure 4.5). Water-tight container for suspending the basket, Dry soft absorbent cloth- 75cm x 45cm (2 nos.), Shallow tray of minimum 650 sq.cm area and Oven.

Procedure
(1) The sample shall be screened on a 10mm IS sieve. The sample should be thoroughly washed to remove finer particles and dust, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 and 32^{o}C.

(2) After immersion, the entrapped air should be removed by lifting the basket and allowing it to drop 25 times in 25 seconds. The basket and sample should remain immersed for a period of 24 + ½ hrs afterwards.

(3) The basket and aggregates should then be removed from the water, allowed to drain for a few minutes, after which the aggregates should be gently emptied from the basket on to one of the dry clothes and gently surface-dried with the cloth, transferring it to a second dry cloth when the first would remove no further moisture. The aggregates should be spread on the second cloth and exposed to the atmosphere away from direct sunlight till it appears to be completely surface-dry. The aggregates should be weighed (Weight 'A').

(4) The aggregates should then be placed in an oven at a temperature of 100 to 110^{o}C for 24hrs. It should then be removed from the oven, cooled and weighed (Weight 'B').

Water absorption = [(A - B)/B] x 100%. Two such tests should be done and the individual and mean results should be reported.

OBSERVATION AND CALCULATION -

weight of sample (before immersed in water)	
Weight of sample (after immersed in water)	
Weight of sample (after drying "A")	
Weight of sample (after oven "B")	
Water absorption amount	

EXPERIMENT NO - 3

Aim: To determine the grade of a given binder.

Apparatus: It consists of items like container, needle, water bath, penetrometer, stop watch etc. Container is

55mm in diameter and 35mm to 57mm height. The needle is provided with a shank approximately 3.0mm in diameter into which it is immovably fixed.

Theory:

The consistencies of bituminous materials vary depending upon several factors such as constituents, temperature, etc. As temperature ranges between 25° and 50°C 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, by measuring the depth (in units of one tenth of a millimeter or one hundredth of a centimeter) to which a standard needle will penetrate vertically under specified conditions of standard load, duration and temperature. Thus the basic principle of the penetration test is the measurement of the penetration (in units of one tenth of a mm) of a standard needle in a bitumen sample maintained at

25C during five seconds, the total weight of the needle assembly being 100gm. The softer the bitumen, the greater will be the penetration. The test is conducted as per IS-1203 for paving bitumen.

Procedure:

> The bitumen is softened to a paving consistency between 75° and 100°C 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°C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25°C for a period of one hour. > The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100gm

> Using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample.

> The needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle.

> The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is noted.

> Then the needle is released by pressing a button and a stop watch is started. The needle is released exactly for a period of 5.0secs.

> At least 3 measurements are made on this sample by testing at distance of not less than 100mm apart.

> The difference between the initial and final penetration readings are taken as the penetration value.

Observation and Calculation:

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

Result .....

EXPERIMENT NO - 4

Aim: To conduct ductility test on given bitumen sample.

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

Theory :

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

Procedure:

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

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

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

> After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at

27°C for 85 to 95 minutes. Then the sides of mould are removed and the clips are carefully booked on the machine without causing any initial strain. Two or more specimens may be prepared in the moulds and clipped to the machine so as to conduct these test simultaneously

>The pointer is set to read zero. The machine is started and the two clips are thus pulled apart horizontally.

>While the test is in operation, it is checked whether the sample is immersed in water at depth of at least 10mm. The distance at which the bitumen thread of each specimen breaks is recorded (in cm) to

report as ductility value.

Observation and Calculation:	**Trails**			**Mean Value**
Test Property	**1**	**2**	**3**	
Ductility Value				

Result: The ductility value of the given bitumen sample is _____ **CM.**

EXPERIMENT NO – 5

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

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

Theory:

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

Procedure:

> Sample material is heated to a temperature between 75° and 100°C 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°C. 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°C per minute with a controlled heating unit, until the bitumen softens and touches the bottom plate by sinking of balls. At least two observations are made. For material whose softening point is above 80°C, glycerin is used for heating medium and the starting temperature is 35°C instead of 5°C.

> The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as so ftening point v alue.

Observation and Calculation:

Test Property	Trails			Mean Value
	1	2	3	
Temperature (°C) at which I ball				
Temperature (°C) at which II ball				
Final Softening Point Temperature				

Result: The softening point value of given bitumen sample is…….

EXPERIMENT NO - 6

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

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

Theory:

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

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

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

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° to 6°C 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:

Test	Trails			Mean Value
	1	2	3	
Flash Point				
Fire point				

Result: The temperature at which the flame application that causes a bright flash ……

_____ °C and temperature at which the sample

EXPERIMENT NO - 7

Aim: To determine the property of a given bituminous material as per IS: 1206.

Apparatus:_A orifice viscometer (one of 4.0mm diameter used to test cut back grades 0 and 1 and10mm orifice to test all other grades), water bath, stirrer and thermometer.

Theory: Viscosity is defined as the increase of fluidity. The degree of fluidity at the application temperature greatly influences the ability of bituminous material to spread, penetrate in to void and also coat the aggregates and hence affects the strength characteristics of the resulting paving mixes. There is an optimum value of fluidity or viscosity for mixing and compacting for each aggregate gradation of the mix and bitumen grade. At high fluidity or low viscosity, the bitumen binder simply "lubricates" the aggregate particles instead of providing a uniform film thickness for binding action. Similarly, low fluidity or high viscosity does not enable the bitumen to coat the entire surface of aggregates. It will increase the compactive force or effort. The test is conducted as per **IS: 1206.**

Procedure:

> The tar cup is properly leveled and water in the bath is heated to the temperature specified for the test and is maintained throughout the test.

> The sample material is heated at the temperature 20 above the specified test temperature and the material is allowed to cool. During cooling the material continuously, stirred.

> When material reaches slightly above test temperature, the same is poured in the tar cup, until the leveling peg on the value rod is just immersed.

> A graduate receiver (cylinder) and a 20m1 of mineral oil or one percent by weight solution of soft soap is poured.

> When the sample material reaches the specified test temperature within ±0.1°C and then valve is opened.

Observation and Calculation:

Test	Trails			Mean Value
	1	2	3	
Viscosity in Sec.				

Result……..

EXPERIMENT NO - 8

Aim: To determine optimum binder content of given bituminous mix by Marshall method of Mix Design.

Apparatus: Mould Assembly, Sample Extractor, Compaction Pedestal and Hammer, Breaking Head, LoadingMachine, flow meter, thermometers, water bath and oven.

Theory:

Bituminous mixes are used in the surface course of road and airfield pavements. The desirable bituminous mix properties include stability, density, durability, flexibility, resistance to skidding and workability during construction. Stability is defined as resistance of the paving mix to deformation under load and is thus a stress level which causes strain depending upon anticipated field conditions. Stability is function of friction and cohesion. Durability is defined as the resistance of the mix against weathering which causes hardening and this depends upon loss of volatiles and oxidation.

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. ASTM vide designation **D 1559-62 T** has standardized the test procedure.

Procedure:

> 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 gradation within the specified range.

> Approximately 1200 gms of aggregates and filler are taken and heated to a temperature of 175° to 190° C.

> The compaction mould assembly and rammer are cleaned and kept pre-heated to a temperature of

100°C to 145°C. The bitumen is heated to temperature of 121° to 138° C and the required quantity of first trail percentage of bitumen is added to the heated aggregate and thoroughly mixed using a mechanical mixer or by hand mixing with trowel.

> Then the mix is heated and a temperature of 150° to 160°C is maintained and then the mix is transferred into the pre-heated mould and compacted by giving seventy five blows on each side

the specific gravity values of different aggregates, filler and bitu men used are dete rmined first. The theoretical specif ic gravity of the mix is determined. 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 weighed in air and then in water.

The bulk density value of the specimen if calculated from weight and volume.

Then the specimens to be tested are kept immersed under water in a thermostatically controlled water bath maintained at 60° + 1° C for 30 to 40 minutes.

The specimens are taken out one by one, placed in the Marshall test head and the Marshall Stability value and flow value are noted.

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 63.5 mm.

Five graphs are plotted with values of bitumen content against the values of density, Marshall Stability, Voids in total mix, Flow value, Voids filled by Bitumen.

Let the bitumen contents corresponding to maximum density be B_1, corresponding to maximum stability be B2 and that corresponding to the specified voids content (at 4.0%) be B3. Then the optimum bitumen content for mix design is given by: $B_0 = (Bi+B2+ B3) / 3$

Observation and calculation -

EXPERIMENT NO - 9

Aim: To determine California Baring Ratio (C.B.R.) value of a given soil sample.

Apparatus:_ Loading machine which can be operated at a constant rate of 1.25mm per minute, cylindrical moulds of 150mm diameter i.e., 175mm height provided with a collar of about 50mm length and detachable perforated base are used for this purpose, Compaction Rammer.

Theory:

The California Bearing Ratio (C.B.R.) test was developed by California Division of Highway as a method of classifying and evaluating soil subgrade and base course materials for flexible pavements. The test is empirical and the results cannot be related accurately with any fundamental property of the material.

The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. The CBR test may be conducted in re-moulded or undisturbed specimen in the laboratory. The test is simple and has been extensively investigated for field correlations of flexible pavement thickness requirement. The test is conducted by causing a cylindrical plunger of some diameter to penetrate a pavement component material at 1.25mm/minute. The loads, for 2.5mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain C.B.R. value. The values are given in the table

Penetration, mm	Standard Load, kg	Unit Standard Load, kg/cm^2
2.5	1370	70
5.0	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

As per IRC recommendation the minimum value of C.B.R. required for a subgrade should be 8%. The procedure is standardized by Indian Standards Institution in two different categories. The first being Test of Soils in laboratory, determination of CBR, **IS: 2720 part XVI.** The second being Methods of Test for soils, field determination of CBR, **IS: 2720 *XXXI***

Procedure:

> Each batch of soil is (of at least 5.5kg for granular soils and 4.5 to 5kg weight for fine grained soils) mixed with water up to the optimum moisture content or the field moisture content if specified so.

> The spacer disc is placed at the bottom of the mould over the base plate and a coarse filter paper is placed over the spacer disc.

> The moist soil sample is to be compacted over this in the mould by adopting either the I.S. light compaction or the I.S. heavy compaction.

> After compacting the last layer, the collar is removed and the excess soil above the top of the mould is evenly trimmed off by means of straight edges.

> The clamps are removed and the mould with the compacted soil is lifted leaving below the base plate and the spacer disc is removed.

> A filter paper is placed on the base plate, the mould with compacted soil is inverted and placed in position over the base plate and clamps of the base plate are tightened.

> Weights of 2.5 to 5kg are placed over the soil sample in the mould. Then the whole mould is placed in water tank for soaking.

> A swelling measuring device consisting of tripod and the dial gauge are placed on top edge of the mould

and the spindle of the dial gauge is placed touching the top of the sample. The initial dial gauge reading is recorded and the test set up is kept undisturbed in the water tank to allow soaking of the soil specimen for four full days or 96 hours.

> After 96 hours of soaking, the mould with specimen is clamped over the base plate and the same surcharge weights are placed on the specimen centrally such that the penetration test can be conducted. The mould with base plate is placed under penetration plunger of the loading machine.

> The penetration plunger is seated at the centre of the specimen and is brought in contact with the top surface of the soil sample by applying a seating load of 4.0kg.

> The dial gauge for the measuring the penetration values of the plunger is fitted in position. The dial gauge of the proving ring and the penetration dial gauge are set to zero. The load is applied through the penetration plunger at a niform rate of 1.25mm/minute. The load readings are recorded at penetration readings of 0.0,

0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0, 12.5 mm penetration. The maximum load value and the corresponding penetration value are recorded.

> After the final reading, the load is released and the mould is removed from the loading machine. The proving

ring calibration factor is noted so that the load dial values can be converted into load in kg.

> The load values noted for each penetration level are divided by the area of the loading plunger (19.635cm^2)

to obtain the pressure.

> A graph is plotted by penetration in mm on x-axis and the pressure in kg/cm^2 on y-axis. Then the unit pressure values corresponding to 2.5 and 5.0mm penetration values are found from the graph. Then the CBR value is calculated from the formul CBR in % =

> The CBR values at 2.5mm and 5.0mm penetrations are calculated for each specimen from the corresponding graphs. Generally the CBR value at 2.5mm penetration if higher and the value are adopted. However if higher CBR value is obtained at 5.0mm penetration, the test is to be repeated to verify the results. If the value at 5.0mm penetration is again higher, this is adopted as the CBR value of the soil sample

Observation and calculation-

Compacting moisture content = Dry

Sample no.	Penetration (mm)	Proving ring dial reading	Load on plunger (kg)	Corrected load (kg)	Unit load kg/cm^2
	0.0				
	0.5				
	1.0				
	1.5				
	2.0				
	2.5				
	3.0				
	4.0				
	5.0				
	7.5				

density =

Result: The CBR value of the given soil sample is……..

EXPERIMENT NO - 10

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

Apparatus:

(1) A steel cylinder of internal diameter 15.2 cm (Steel cylinder with open ends)

(2) A square base plate, plunger having a piston diameter of 15 cm.

(3) A cylindrical measure of internal diameter of 11.5 and height 18 cm

(4) Steel tamping rod having diameter of 1.6 cm length 45 to 60 cm.

(5) Balance of capacity 3 kg with accuracy up to 1 gm.

(6) Compression testing machine capable of applying load of 40 tonnes at a loading rate of 4 tonnes per minute.

Theory:

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 rolleduring 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 equa 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_i gm.

> Then the cylinder of test apparatus is kept on the base plate and one third of the sample from cylindrical measure is transferred into cylinder and tamped 25 times by rounded end of the tamping rod.

> Similarly aggregate in three layers of approximately equal depth, each layer being tamped 25 times by rounded end of the tamping rod.

> Then the cylinder with test sample and plunger in position is placed on compression testing machine.

> Load is then applied through the plunger at a uniform rate of 4 tonnes per minute until the total load is 40 tonnes and the load is released.

> Aggregates including the crushed position are removed from the cylinder and sieved on a 2.36mm IS. sieve and material which passes this sieve is collected and weighed. Let this be w_2 gm.

> The above step is repeated with second sample of the same aggregate. The two tests are made for the same specimen for taking an average value.

> Total weight of dry sample taken is w_i gm weight of the portion of crushed material passing 2.36mm IS sieve be w_2 gin.Then the aggregate crushing value is defined as the ratio of weight of fines passing the specified ISsieve to the total weight of the sample (w_i). Aggregate crushing value = $100*w_2/w_I$

Observation and calculation

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

Result:

The mean (average) of the crushing value aggregate is

EXPERIMENT NO - 11

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

Apparatus:

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

Theory:

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:-

(1) 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%.

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

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

(4) 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 5Kg for grading A, B, C or D and 10Kg for grading E, F or G may be taken as test specimen and placed in the cylinder.

> The abrasive charge is also chosen in accordance with table no.1 and placed in the cylinder of the machine, and cover is fixed to make dust tight.

> The machine is rotated at a speed of 30 to 33 revolutions per minute.

> The machine is rotated for 500 revolutions for grading A, B, C and D, for grading E, F and G, it shall be rotated for 1000 revolutions.

> After the desired number of revolutions, the machine is stopped and the material is discharged from the machine taking care to take out entire stone dust.

> Using a sieve of size larger than 1.70mm I.S sieve, the material is first separated into two parts and the finer position is taken out and sieved further on a 1.7mm I. S sieve.

> Let the original weight of aggregate be $w_i$gm, weight of aggregate retained on 1.70mm I. S sieve after the test be $w_2$gm.

Observation and Calculation

TABLE NO. 1

ot	Weight in grams of each test **sample** in **the size range,** mm **(Passing and retained** on										Abrasive Charge.	
	80-63	63-50	50-40	40-25	25-20	20-12.5	12.5-10	10-6.3	6.3-4.75	4.75-2.36	No. of	Weight of
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

Sl.	**Details of Sample**	**Trail 1**	**Trail 2**	**Average**
1	**Weight of Specimen** = W1 g			
2	**Weight of Specimen after abrasion test, coarser than1.70 mm IS sieve** = W2 g			
3	**Percentage wear** = $((W_I - W_2) / W_1 * 100$			

Result……..

EXPERIMENT NO - 12

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

Apparatus:_ The apparatus consists of an Impact testing machine: The machine consists of a metal base. A detachable cylindrical steel cup of internal diameter 10.2cm and depth 5cm. A metal hammer of weight between 13.5 to 14Kg, 10cm in diameter and 5cm long. An arrangement for raising the hammer and allow it to fall freely between vertical guides from a height of 38cm on the test sample in the cup. A cylindrical metal measure having 7.5cm and depth of 5cm for measuring aggregates.

- ✓ A tamping rod of circular cross section, 1 cm in diameter and 23cm long, rounded at one end.
- ✓ I.S. sieve of sizes 12.5mm, 10mm and 2.36mm.
- ✓ Balance of capacity not less than 500gm to weigh accurate up to 0.01gm.

Theory:

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 12.5mm sieve and retained on 10mm sieve and dried inan oven for 4 hours at a temperature of 100 C to 110 C.

> The aggregates are filled upto about 1/3 full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod.

> The rest of the cylindrical measure is filled by two layers and each layer being tamped 25 times.

> The overflow of aggregates in cylindrically measure is cut off by tamping rod using it has a straight edge.

> Then the entire aggregate sample in a measuring cylinder is weighted nearing to 0.01 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 38cm above the upper surface of aggregates in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate is than removed from the cup and the whole of it is sieved on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample.

> Let the original weight of the oven dry sample be $w_i$gm and the weight of fraction passing 2.36mm I.S sieve be $w_2$gm. Then aggregate Impact value is expressed as the % of fines formed in terms of the total weight of the sample.

Observation and calculation -

Sl. No.	Details of Sample	Trail 1	Trail 2	**Average**
1	Total Weight of aggregate sample filling the cylinder measure = W1 g			
2	Weight of aggregate passing 2.36 mm sieve after the test = W2 g			
3	Weight of aggregate retained 2.36 mm sieve after the test = W2 g			
4	(W1- W2 + ^{W}3)			
5	Aggregate Impact Value = (W_2 / W_1) * 100 Percent			

Result:

The mean A.I.V is……

EXPERIMENT NO - 13

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

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

Theory:

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 315th (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

ELONGATION INDEX**:** The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than 1 and 415 th times (1.8 times) their mean dimensions. The elongation test is not applicable to sizes smaller than 6.3mm.

ANGULARITY NUMBER**:** The angularity number of an aggregate is the amount by which the percentage voids exceeds 33 after being compacted in a prescribed manner. The minimum allowable combined index of aggregates used in surface course in different types of pavement is 30%.

Procedure: The sample is sieved with the sieves mentioned in the table.

1. A minimum of 200 pieces of each fraction to be tested are taken and weighed (wlgm).

2. 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.

3. Then the amount of flaky material passing the gauge is weighed to an accuracy of at least 0.1%

of test sample.

4. Let the weight of the flaky materials passing the gauge be wlgm. Similarly the weights of the fractions passing and retained on the specified sieves be wl, w2, w3, etc. are weighed and the total weight wl+w2+w3+ = wg is found. Also,the weights of the materials passing each of the specified thickness gauge are found = W1, W2, W3... and the total weight of the material passing the different thickness gauges = W1+W2+W3+=Wg is found.

5. 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

6. Flakiness Index=

Observation and Calculation:

SIZE OF AGGREGATE		THICKNESS GAUGE (0.6 TIMES THE MEAN	Weight of the fraction consisting of at least 200 pieces in gm.	Weight of aggregates in each fraction passing thickness gauge, gm.
PASSING THROUGH I.S. SIEVE mm	RETAINED ON I.S. SIEVE mm			
63	50	33.90		
50	40	27.00		
40	25	19.50		
31.5	25	16.95		
25	20	13.50		
20	16	10.80		
16	12.5	8.55		
12.5	10.0	6.75		
10	6.3	4.89		

Result: The flakiness index of the given sample of aggregates is……

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

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

Procedure:

> The sample is sieved through I.S-sieves specified in the table. A minimum of 200 aggregate pieces . of each fraction is taken and weighed

> Each fraction is thus gauged individually for length in a length gauge. The gauge length is used should be those specified in the table for the appropriate material.

> The pieces of aggregates from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and they are collected separately to find the total weight of aggregate retained on the length gauge from each fraction.

> The total amount of elongated material retained by the length gauge is weighed to an accuracy of at least

0.1% of the weight of the test sample.

> The weight of each fraction of aggregate passing and retained on specified sieves

sizes are found – WI, W2, W3, ...And the total weight of sample determined= Wi+W2+W3+.....= Wg. Also the weights of material from each fraction retained on the specified gauge length are found = x_i, x_2, x_3... and the total weightretained determined = x_i-Fx_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.

Elongation Index .....

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 aggregates in each fraction retained on length gauge, gm.
PASSING THROUGH I.S. SIEVE mm	RETAINED ON I.S. SIEVE mm			
63	50	-		
50	40	81.00		
40	25	58.50		
31.5	25	-		
25	20	40.50		
20	16	32.40		
16	12.5	25.60		
12.5	10.0	20.20		
10	6.3	14.70		

Result: The elongation index of a given sample of aggregate is