



CT LAB MANUAL

B. Tech III Year - I Semester



NAME: _____

ROLL NO: _____

BRANCH: _____



DEPARTMENT OF CIVIL ENGINEERING



Aurora's Technological & Research Institute
Parvathapur, Uppal, Hyderabad-98



TESTING ON CEMENT AND CONCRETE

EXPERIMENT 1

STANDARD CONSISTENCY OF CEMENT

AIM: To determine the quantity of water required to produce a cement paste of standard consistency.

DEFNITION: Standard consistency is defined as that consistency which will permit the Vicat's plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould when the cement is tested.

APPARATUS:

1. Vicat's apparatus, Mould, Plunger.
2. Standard trowel
3. Stop watch.
4. Weighing balance

DESCRIPTION:

The Vicat's apparatus consists of a frame and a moving rod weighing 300 gm. The plunger is kept at the lower end of the rod. It is a cylinder 10 mm. Diameter, A pointer connected to the rod will move along with it when it is released, over a graduated scale kept in front of it. The cement paste to be tested is kept in the Vicat's mould kept below the rod on a glass plate.

PROCEDURE:

1. Carefully weigh 400 gm of cement and place it on a non-porous surface.
2. Form a crater in the centre in which add about 100 to 120 cc. of water.
3. Thoroughly mix the cement with water and fill, the Vicat's mould with the paste.
4. The interval from the moment of adding water to the dry cement to the moment of commencing to fill the mould is known as the time of gauging



and shall not be less than 3 minutes and more than 5 minutes. Lower the plunger gently and test the penetration.

5. If the penetration is between 5 to 7 mm from the bottom of the mould the quantity of water added is the required consistency.
6. Otherwise repeat the test with different percentages of water until the required penetration is obtained. Express the amount of water as a percentage by weight of the dry cement.

OBSERVATIONS:

S. No.	Weight of Cement W_1	Weight of water W_2	Reading on scale mm	W_2 / W_1	Standard consistency

CALCULATIONS: Weight of cement taken = W_1 .

Weight of water added when the plunger has a penetration of 5 to 7 mm from the bottom of the mould = W_2

Percentage of water for standard consistency

$$p = (W_2 / W_1) \times 100$$

RESULT: Percentage of water for standard consistency is

INFERENCE:



EXPERIMENT 2

SETTING TIME OF CEMENT

AIM: To determine the initial and final setting times of cement.

APPARATUS: The Vicat's apparatus, Needle, Annular ring, Trays, Balance and Weights.

PROCEDURE:

1. Preparation of Test Block: Prepare a neat cement paste by gauging the cement with 0.85 times the water required to give the paste of standard consistency. Start a stopwatch at the instant when water is added to the cement. Fill the Vicat's mould with a cement paste with in three to five minutes after addition of water. Fill the mould completely and smooth off the surface of this paste making it level with the top of the mould. The cement block thus prepared in the mould is test block.
2. Clean appliances shall be used for gauging. The temperature of water and that of the test room at the time of gauging shall be with in $(27 \pm 2) ^\circ\text{C}$.
3. During the test the block shall be kept at a temperature of $(27 \pm 2)^\circ\text{C}$ and at least 90% relative humidity.

a) Determination of Initial Setting Time:

Place the test block confined in the mould and resting on the nonporous plate, under the rod bearing the needle, lower the needle gently in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block. In the beginning the needle will completely pierce the test block. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block for 5 to 7 mm measured from the bottom of the mould. The period elapsing between the time when water is added to the cement and this time shall be initial setting time.

**b) Determination of Final Setting Time:**

Replace the needle of the Vicat's apparatus with the needle with a circular attachment. The cement shall be considered as finally set, when upon lowering the needle gently to the surface of the test block the needle makes an impression there on, while the attachment fails to do so. In other words the paste has attained such hardness that the centre needle does not pierce through the paste more than 0.5mm.

The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface on the test block while the attachment fails to do so shall be the final setting time.

OBSERVATIONS:**INITIAL SETTING TIME:**

S. No.	Time	Reading on the scale of Vicat's apparatus

FINAL SETTING TIME:

S. No.	Time	Reading on the scale of Vicat's apparatus

RESULT:

Initial setting time of the cement =

Final setting time of the cement =

SPECIFICATION: As per I.S.: 269 - 1989 the initial setting time should not be less than 30 minutes and final setting time should not be more than 600 minutes for ordinary Portland cement.

**EXPERIMENT 3****SPECIFIC GRAVITY OF CEMENT****REF: I.S 4031 - 1988****AIM: To determine the specific gravity of cement****DEFINITION:** Specific gravity of cement is defined as the ratio of weight of a given volume of cement at a given temperature to the weight of an equal volume of distilled water at the same temperature both weights being taken in air.**APPARATUS:** Specific gravity bottle, weighing balance**MATERIAL:** Kerosene free of water, naphtha having a specific gravity not less than 0.7313 shall be used in the specific gravity determination.**PROCEDURE:**

1. Wt. of empty dry specific gravity bottle = W_1
2. Wt. of bottle + Cement (filled 1/4 to 1/3) = W_2
3. Wt. of bottle + Cement (Partly filled) + Kerosene = W_3
4. Wt. of bottle + Kerosene (full). = W_4
5. Wt. of bottle + water (full) = W_5

$$\text{Specific gravity of kerosene } S_k = \frac{(W_4 - W_1)}{(W_5 - W_1)}$$

$$\text{Specific gravity of Cement} = \frac{(W_2 - W_1) \times S_k}{(W_4 - W_1) - (W_3 - W_2)}$$

RESULT: Specific Gravity of cement =**SPECIFICATIONS:****INFERENCE:**



EXPERIMENT 4

COMPRESSIVE STRENGTH OF CEMENT

AIM: To find the compressive strength of given sample of cement.

APPARATUS: 7.07cm cube moulds (50cm² c/s area), compression testing machine, vibrating machine, Balance, Weights and Trays.

PROCEDURE: Measure the given cement and standard sand in the proportion 1:3 by weight.

1. **Standard sand:** It shall pass the 850 micron I.S. sieve and not more than 10% by weight shall pass the 600 micron I.S. sieve. Take 200 gms of cement and 600 gms of standard sand in a pan. Mix it dry with a trowel for one minute and then add water. The quantity of water shall be $(0.25 P + 3)$ percent of combined weight of cement and sand, where P is the % of water required to produce a paste of standard consistency determined earlier. Add water and mix it until the mixture is of uniform colour. The time of mixing shall not be less than 3 minutes and not greater than 4 minutes.
2. Immediately after mixing the mortar place the mortar in the cube mould and tamp with the help of the tamping rod. The mortar shall be rodded 20times in about 8 seconds to ensure elimination of entrained air.
3. If vibrator is used the period of vibration shall be two minutes at the specified speed of 12000 vibration per minutes.
4. Then place the cube moulds in an atmosphere of $27^0 \pm 2^0c$ and 90% relative humidity, submerge in clear fresh water till testing.
5. Take out the cubes from water just before testing. Testing should be done on their sides with out any packing. The rate of loading should be uniform and of 350kg/cm²/minute.



6. Three cubes should be tested and their average should be taken as the test result. Report the result in Kg/cm^2 .

OBSERVATIONS: Compressive load at three days =
Compressive load at seven days =

RESULT: Compressive strength of cement at three days =
Compressive strength of cement at seven days =

I.S. Specification: For ordinary Portland cement of grade 33 the crushing strength shall not be less than 16 MPa at 3 days, 22 MPa at 7 days and 33 MPa at 28 days.

INFERENCE:



EXPERIMENT 5

WORAKABILITY OF CONCRETE - SLUMP TEST

AIM: To determine the workability of concrete mix of given proportion by slump test.

APPARATUS: Iron Pan to mix concrete, weighing machine, trowel, slump cone, scale and tamping rod.

DESCRIPTION: The slump cone is a hollow frustum made of thin steel sheet with internal dimensions as, the top diameter 10cm, the bottom diameter 20 cm, and height 30 cm .It stands on a plane non- porous surface. To facilitate vertical lifting from molded concrete it is provided with a suitable guide attachment and suitable foot places and handles. The tamping rod is 16mm dia 60cm long and is bullet pointed at the lower end.

THEORY:

Unsupported concrete, when it is fresh, will flow to the sides and a sinking in height will take place. This vertical settlement is called slump. Slump is a measure indicating the workability of cement concrete and also slump gives an idea of W/C ratio needed for concrete to be used for different works. Slump increases with W/C ratio. A concrete is said to be workable if it can be easily mixed and easily placed compacted and easily finished.

PROCEDURE:

Mixes are prepared with W/C. ratio 0.4, 0.5, 0.55 and 0.6. For each mix take
C.A. = 10 kg, F.A. = 5 kg and Cement = 2.5 kg.

- 1) Mix the dry constituents to get a uniform color and then add water.
- 2) The internal surface of the mould is to be thoroughly cleaned and place on a smooth, horizontal, rigid and non-absorbent surface.



- 3) Place the mixed concrete in the cleaned slump cone in 4 layers each approximately $\frac{1}{4}$ in height of the mould . Tamp each layer 25 times with tamping rod.
- 4) Remove the cone immediately, rising it slowly and carefully in the vertical direction.
- 5) As soon as the concrete settlement comes to a stop, measure the subsidence of the concrete in mm, which gives the slump.

OBSERVATIONS:

S. No.	W/C Ratio	Slump	Type of Slump
1	0.45		
2	0.5		
3	0.55		
4	0.6		
5	0.65		

RESULT:**SPECIFICATIONS:**

As per I.S: 456 the degree of workability is classified as follows.

Degree of workability	Slump
Very low	0mm to 25mm
Low	25mm to 50mm
Medium	50 mm to 100 mm.
High	100 mm to 175 mm.

INFERENCE:



WORKABILITY OF CONCRETE COMPACTING FACTOR TEST

AIM: To determine the workability of concrete mix of given proportions by compacting factor test.

APPARATUS: Compacting factor apparatus, Balance, Weights, Trays, Tamping rod and Trowels.

DESCRIPTION: Compacting factor apparatus consists of two conical hoppers mounted above a cylindrical mould and fixed to a stand one above the other. The hoppers are provided with trap doors at the bottom. The dimensions of various parts are given below.

1. Upper Hopper	Dimensions in cm.
Top internal dia.	25.4
Bottom	12.7
Internal height	27.9
2. Lower Hopper	Dimension in cm.
Top internal dia.	22.9
Bottom	12.7
Internal height	22.9
3. Cylinder	Dimension in cm.
Internal Diameter	15.2
Internal Height	30.5

Distance between bottom of upper hopper and top of lower hopper is 20.3 cm.

Distance between bottom of lower hopper and top of cylinder is 20.3 cm.



DEFINITION:

Compacting factor is defined as the ratio of weight of partially compacted concrete to the weight of fully compacted concrete.

PROCEDURE:

Four mixes are prepared with W/C., ratios 0.4, 0.5, 0.55, 0.6 and 0.65. For each mix take 2.5 kg of cement, 5 kg of fine aggregate and 10 kg of coarse aggregate.

1. Mix the dry constituents to get a uniform color and then add water.
2. The internal surfaces of the hoppers and cylinder are thoroughly cleaned.
3. The sample of concrete to be tested is placed gently in the upper hopper.
4. The hopper is filled level with its brim and the trap door is opened so that the concrete falls into the lower hopper.
5. If concrete has a tendency to stick to the sides of the hopper, the concrete should be slowly pushed down by inserting the tamping rod into the concrete.
6. Immediately after the concrete comes to door of the lower hopper, it is opened and the concrete is allowed to fall into the cylinder.
7. The excess of concrete in the cylinder above the top is cut off and made level with trowels. The outside of cylinder is wiped clean.
8. The weight of the concrete in the cylinder is then determined. This weight is known as weight of partially compacted concrete.
9. The cylinder is refilled with concrete from the same sample in six layers and each is rammed thoroughly.
10. The top of fully compacted concrete should be carefully struck off level with top cylinder. The outside of the cylinder is wiped a clean and the weight of fully compacted concrete is found.

**OBSERVATIONS:**

S. No.	W/C	W ₁	W ₂	W ₂ -W ₁	W ₃	W ₃ -W ₁	C.F. = (W ₂ -W ₁ / W ₃ -W ₁)

CALCULATIONS:

Weight of cylinder	W ₁	=
Weight of cylinder + partially compacted	W ₂	=
Weight of Partially compacted concrete	(W ₂ -W ₁)	=
Weight of cylinder + fully compacted concrete	W ₃	=
Weight of fully compacted concrete	(W ₃ -W ₁)	=
Compacting factor	(W ₂ -W ₁) / (W ₃ -W ₁)	=

RESULTS:

Maximum workability of concrete is occurring at a water / cement ratio of

SPECIFICATIONS:

According to IS 456, the degree of workability is classified as follows:

Degree of workability	Compacting factor.
Very Low	0.75 to 0.8
Low	0.8 to 0.85
Medium	0.85 to 0.92
High	0.92 & above.

GRAPH:

A graph is drawn with water / cement ratio on x-axis and values of compaction factor on y-axis.

INFERENCE:



WORKABILITY OF CONCRETE - VEE BEE TEST

AIM: To find workability of concrete by Vee-Bee consistency test in terms of Vee Bee Seconds

APPARATUS:

Vee Bee consistometer, Stopwatch, Balance, Tray, Tamping rod, measuring jar, Weights and Trowels.

THEORY:

The consistometer is used for determining the consistency of concrete by vibrating and transforming a concrete specimen from the shape of conical frustum into a cylinder.

DESCRIPTION:

The consistometer consists of a

1. A vibrator table, which vibrates a rate of 3000 vibrations / min.
2. A metal pot, which holds the specimen when the concrete is vibrated. It is secured to the vibrator table by bolts.
3. Slump cone of 300 mm high, 200 mm at the bottom and 100 mm at the top (Open both ends).
4. Swivel arm holder: A tube, which is fixed the rear of the base of the vibrator table. It has 4 positioning slots for swivel arm to position the metal cone over the slump cone or Perspex disc on the specimen or to position both of them away.
5. Swivel arms the Swivel moves freely inside the swivel arm holder. A metal rod and a guide sleeve are fixed to the swivel arm. The graduated metal rod passes through the guide sleeve.
6. Metal cone - this is in the form of a frustum of cone with open ends (funnel). This is fixed to the swivel arm
7. Graduated rod
8. Tamping rod. A metal rod of 16 mm x 60 cm. long with one end bullet ended.



PROCEDURE:

1. Position the metal cone over the slump cone. Place the concrete inside the slump cone in 4 layers each approximately 1/4 of the height. Strokes are applied by the rounded end of the tamping rod. Distribute the strokes in a uniform manner over the cross section.
2. After the top layer has been rodded, position the metal cone of the swivel arm away, and strike off the concrete, level with the top of the cone using a trowel so that the mould is exactly filled.
3. Remove any material spilled inside the metal pot or sticking on to the side of the slump filled.
4. Position the Perspex disc over the cone and note down the reading on the graduated rod (L_1). After keeping the disc away, lift the slump cone vertically and remove.
5. Position the disc over the concrete. Note down the reading of the graduated rod (L_2). The difference in the readings gives the slump in Centimeters.
6. Switch on the vibrator starting a stopwatch simultaneously. Allow the concrete to spread out in the pot. When the whole concrete surface uniformly adheres to the Perspex disc, stop the watch, simultaneously, switch off the vibrator. Note down the time in seconds. Also note the reading on the graduated rod (L_3).
7. The consistency of the concrete is expressed in Vee-Bee degrees which are equal to the time in seconds.
8. Repeat the procedure of different W/C ratios viz.: 0.4, 0.5, 0.55, 0.6 & 0.65.
9. Draw a graph between slump in centimeters and Vee - Bee Degrees.
10. Knowing the dia of the disc and the height of the concrete after Vibration ($30 + L_1 - L_3$), the Volume of the concrete can be computed.



OBSERVATIONS:

S. No.	W/C Ratio	Slump (mm)	Vee-Bee Seconds

RESULT:

SPECIFICATIONS:

INFERENCE:



EXPERIMENT 6

CUBE COMPRESSIVE STRENGTH OF CONCRETE

AIM: To determine the compressive strength of concrete using 15 x 15 x 15 cm concrete cubes.

APPARATUS: Compressive testing machine, Balance, Trays, Weights, Moulds and Trowels.

PROCEDURE:

1. Place the cube at the centre of the lower platen of the compression testing machine in such a manner that the load shall be applied to opposite sides of the cube as cast, that is, not to the top and bottom.
2. The axis of the specimen shall be carefully aligned with the centre of the thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine.
3. The load shall be applied without shock and increased continuously at a rate of approximately $140\text{kg}/\text{cm}^2/\text{min}$. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.
4. The maximum load applied to the specimen shall then be recorded.

OBSERVATIONS:

Measured side of cube	=	cm
Weight of the cube	=	kg.
Load at first crack	=	kg.
Load at ultimate failure	=	kg.



CALCULATIONS:

Initial crack strength of concrete $\frac{\text{Load at first crack}}{\text{c/s area of the specimen}}$

Ultimate cube compressive strength of the concrete = $\frac{\text{Maximum Load}}{\text{c/s area of the specimen}}$

Safe compressive strength of concrete $\frac{\text{Ultimate strength}}{\text{Factor of safety}}$

= $\frac{\text{Ultimate strength}}{3}$

RESULT:

INFERENCE:



EXPERIMENT 7

BULKING OF SAND by LAB. METHOD

AIM: To ascertain the bulking Phenomena of given sample of sand.

APPARATUS: Special Vessel for unit volume, tray, balance and weights,

THEORY:

Increase in volume of sand due to presence of moisture is known as Bulking of sand. Bulking is due to the formation of thin film of water around the sand grains and the interlocking of air in between the sand grains and the film of water. When more water is added a sand particles got submerged and volume again becomes equal to dry volume of sand. To compensate the bulking effect extra sand is added in the concrete so that the ration of coarse to fine aggregate will not change from the specified value. Fine sands shown greater percentage of bulking than coarse sands with equal percentage of moisture.

PROCEDURE:

Compact the sand in three layers in the vessel, each layer being given 25 strokes, and strike level at top. Weigh it and dump it into a tray. Add a certain percent of water by weight (say 2%) of dry compacted tray. Add a certain percent of water by weight (say 2%) of dry compacted sand. Mix, well till uniformly moist. Fill the container with the wet sand without any tamping strike tip surface level, and find weight of the wet loose sand.

Repeat this with moisture contents of 4,6,8,10,12,14,16,18 and 20%.

**OBSERVATIONS:**

S. No.	% of water added (X%)	Wt. of wet sand W_2 gm	Wt. of dry sand in wet sand W_3 gm. = $W_2 / (1+0.01 x)$	Bulk Factor = W_1 / W_3	Bulking % = $(B.F-1) * 100$
1	2				
2	4				
3	6				
4	8				
5	10				
6	12				
7	14				
8	16				
9	18				
10	20				

CALCULATIONS:

Weight of unit volume of dry compacted sand = W_1

Weight of loose wet sand of unit volume = W_2

If moisture content be $x\%$ in sand, and if W_3 is weight of dry sand in W_2 of loose wet sand,

$$\text{Then } W_2 = W_3 + (0.01) x W_3$$

$$W_3 = W_2 / (1+0.01 X).$$

$$\text{Bulking factor (B.F.)} = W_1 / W_3.$$

$$\text{Bulking percentage} = (W_1 - W_3) X 100 / W_3.$$

or $(B.F. - 1) X 100.$

GRAPH: Plot graph between B.F. on (Y- axis) and water content on (X- axis).

RESULT:

1. Moisture content at maximum bulking =
2. Percentage of maximum bulking =

SPECIFICATION:**INFERENCE:**



BULKING OF SAND by FIELD METHOD

AIM: To ascertain the bulking phenomena of given sample of dry sand.

BULKING FACTOR:

The bulking factor is defined as the ratio of the volume of moist sand to volume of the sand when dry.

BULKING PERCENTAGES:

It is defined as the ratio of increase in volume of moist sand to the volume of sand when dry.

PROCEDURE:

1. Take about 200gms of dry sand in a 1 liter jar and find its volume (V_1)
2. Put the above sand in a mixture pan and add 2% water by weight. Mix it thoroughly to get uniform color.
3. Fill this moist sand into the 1 liter cylinder and note down the volume (V_2)
4. The increase in volume is ($V_2 - V_1$) and the percentage of bulking is $\frac{V_2 - V_1}{V_1} \times 100$
5. The bulking factor $\frac{V_2}{V_1}$
6. Repeat the experiment with different percentages of water i.e., 4,6,8,12,16%
7. Plot the graph of bulking factor on Y axis v/s moisture content by percentage of dry mass of sand on X-Axis. This is known as bulking curve.

The field test to find out the percentage of bulking is so simple that this could be conducted in a very short time interval and the percentage of bulking so found out could be employed for correcting the volume of fine aggregate to be used. This can be considered as one of the important methods of field control to produce quality concrete. Since volume batching is not adopted for controlled concrete, the determination of the percentage of moisture content is not normally required. The quality of water could be controlled by visual examination of the mix and by experience. The percentage free moisture content is required to be



determined and correction made only when weigh batching is adopted for production of quality concrete.

SNo	Water Content %	V ₁	V ₂	(V ₂ -V ₁)	Bulking percentage $\frac{V_2 - V_1}{V_1} \times 100$	Bulking factor $\frac{V_2}{V_1}$
1	2					
2	4					
3	6					
4	8					
5	12					
6	16					



HIGHWAY ENGINEERING LAB - ROAD AGGREGATES

EXPERIMENT 1

AGGREGATE CRUSHING VALUE TEST

AIM: To find Aggregate Crushing value of the given aggregate sample.

APPARATUS:

Steel cylinder, cylindrical measure, Steel tamping rod, Balance, Compressions testing machine

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° C 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, the aggregate at the top of the cylindrical measure is leveled off by using the tamping rod as a straight edge. About 6.5 kg of aggregate is required for preparing two test samples. The test sample thus taken is then weighed. The same weight of the sample is taken in the repeat test.

The cylinder of the test apparatus is placed in position on the base plate; 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 10 cm. The surface of the aggregate is leveled and the plunger inserted so that it rests on this surface in level position. The cylinder with the 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 tones per minute until the total load is 40 tones, 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 = W_1 gm.

Weight of the portion of crushed material passing 2.36 mm IS sieve = W_2 gm

Aggregate crushing value = $100 \frac{W_2}{W_1}$

RESULT:

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

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 pavements should be strong enough to withstand the high stresses due to wheel loads, including the steel tyres of loaded bullock-carts. However as the stresses at the base and sub-base courses are low aggregates with lesser 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 aggregates used for cement pavement at surface should not exceed 30 percent. For aggregates used for concrete other than for wearing surfaces, the aggregate crushing value shall not exceed 45 percent, according to the ISS. However aggregate crushing values have not been specified by the IRC for coarse aggregates to be used in bituminous pavement construction methods.



EXPERIMENT 2

AGGREGATE IMPACT VALUE TEST

AIM: To find Impact value of the given aggregate sample.

APPARATUS

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

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^o C to 110^o C and cooled. The aggregates are filled up to about one-third full in the cylindrical measure and tamped 25 times with rounded end of the tamping rod. Further quantity of aggregates are struck off using the tamping rod as straight edge. The net weight of the aggregates in the measure is determined to the nearest gram and this weight of the aggregates is used for carrying out duplicate test on the same material. The impact machine is placed with its bottom plate flat on the floor so that the hammer guide columns are vertical. The cup is fixed firmly in position on the base of the machine and the whole of the test sample from the cylindrical measure is transferred to the cup and compacted by tamping with 25 strokes.

The hammer is raised until its lower face is 38 cm above the upper surface of the aggregates in the cup, and allowed to fall freely on the aggregates. The test sample is subjected to a total of 15 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.

RESULT:

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

M 10%	exceptionally strong;	10-20%	Strong
10-30% surfacing	satisfactorily for road surfacing;	0 35%	Weak for road

$$\begin{aligned}\text{Weight of the oven dry aggregate} &= W_1 \text{ gm} \\ \text{Weight of fraction passing 2.36 mm sieve} &= W_2 \text{ gm} \\ \text{Aggregate Impact value} &= W_2 / W_1 \times 100\end{aligned}$$

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 aggregates, 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 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.



TABLE 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 surfacing (ii) Built up-spray grout, base course	40
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/ Asphaltic concrete (viii) Cement concrete, surface course	30



EXPERIMENT 3

SPECIFIC GRAVITY AND WATER ABSORPTION TEST

AIM: To find out the specific gravity and water absorption of the given aggregate

APPARATUS:

1. Balance
2. Oven to maintain temp of 100°C to 110°C
3. Wire basket
4. Container with water
5. Trays

PROCEDURE:

About 2 Kg of the aggregate sample is washed thoroughly and placed in the wire basket when immersed in distilled water. The basket and the sample are then weighed (W_1) while suspended in water at a temp of 22°C to 32°C. The aggregates are then placed on the absorbent clothes and should be cleaned. The surface dry aggregates is then weighed (W_2). The aggregate is placed in a shallow tray and kept in an oven maintained at a temp of 110°C for 24 hours. It is then removed from the oven, cooled in an air tight container and weighted (W_4).

OBSERVATIONS:

Weight of saturated aggregate suspended in water with the basket	= W_1
Weight of basket above suspended in water	= W_2
Weight of saturated aggregate in water	= $(W_1 - W_2)$
Weight of saturated surface dry aggregate in air	= W_3
Weight of Water equal to the volume of the aggregate	= $W_3 - W_5$

CALCULATIONS:

Specific Gravity= dry weight of aggregate/ weight of equal volume of water =

$$\frac{W_4}{W_3 - W_5}$$



Water Absorption, % = Percentage by weight of water absorbed in terms of oven dried weight of aggregate

$$= \frac{W_3 - W_4}{W_4} \times 100$$

INTERFERENCE:

The specific gravity of aggregates normally used in road construction ranges from about 2.5 to 3.0 with an average value of 2.68. Water absorption value ranges from 0.1 to 2.0 % for aggregates normally used in road surfacing IRC has specified the maximum water absorption values as 10 percent for aggregate used in bituminous surface dressing and built up spray grow.



EXPERIMENT 4

LOS ANGELES ABRASION TEST

AIM: To find the Los Angeles abrasion value of given aggregate sample

APPARATUS: The apparatus consists of Los Angeles machine, abrasive charge and sieves.

Los Angeles machine consists of a hollow steel cylinder, closed at both ends, having an inside diameter 70cm 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 radial 8.8 cm into the parallel to the axis. The shelf is fixed at a distance of 12.5 cm from the opening, measured along the circumference in the direction of rotation. 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 of the aggregates tested. The aggregates 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 11.1. 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 105-110⁰ C to constant weight, conforming to any one of the grading A to G, as per Table 11.1 is used for the test. The grading or grading's used in the test should be nearest to the grading to be used in the construction. Aggregates weighing 5 kg for grading A, B, C or D and 10 kg for grading E, F or G may be taken as test specimen and placed in the cylinder. The abrasive charge is also chosen in accordance with Table 1 depending on the grading of the aggregate and is placed in the cylinder of the machine. The cover is then fixed dust-tight. The machine is rotated at a speed of 30 to 33 revolutions per minute. The machine is rotated for 500 revolutions for grading A, B, C and D, for



grading's 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, 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° C to constant weight and weighed correct to one gram.

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.

TABLE 1
Specifications for Los Angeles Test

Grade	Weight in grams of each test sample in the size range, mm (Passing and retained on square holes)										Abrasive Charge	
	80-63	63-50	50-40	40-25	25-20	20-12.5	12.5-10	10-6.3	6.3-4.75	4.75-2.36	No. Of Spheres	Wt. of charge
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

* Tolerance of ± 2 percent is permitted.

Let the original weight of aggregate = W_1 g

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



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

RESULT:

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

INTERFERENCE:

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 1.

TABLE 11.2
Maximum Allowable Los Angeles Values of Aggregates in Different
Types of Pavement Layers

Serial No.	Types of pavement layer	Los Angeles abrasion value, maximum %
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 (iii) Bituminous penetration Macadam (iv) Built-up spray grout binder course	40
4	(i) Bituminous carpet surface course (ii) Bituminous surface dressing, single or two coats (iii) Bituminous surface dressing, using pre-coated aggregates. (iv) Cement concrete surface course (as per IRC)	35
5	(i) Bituminous/Asphalt concrete surface course (ii) Cement concrete pavement surface course (as per ISI)	30



EXPERIMENT 5

DEVAL ATTRITION TEST

AIM: To determine the coefficient of hardness or resistance to wear of stone aggregate

APPARATUS: LOS Angeles machine, Deval attrition test machine, sieves, weighing balance, charges

THEORETICAL BACKGROUND: The aggregate used in pavements is subjected to huge amounts of wear and tear. Hence it is imported to know the hardness and resistance offered by the material.

$$\text{Percentage Wear} = \frac{\text{Loss of weight due to wear}}{\text{Original weight}} \times 100$$

PROCEDURE:

1. Take 5 kg of dried aggregates and 6 steel charges introduce them into two different cylinders.
2. Rotate the machine at 30 to 33 rpm for 10,000 revolution
3. After completion of revolutions discharges the material from the machine.
4. Sieve the remains through 1.7 mm is sieve
5. Wash and dry the material coarser than 1.7 mm and weigh it.

RESULT: Percentage of wear = 10%

**EXPERIMENT 6****AGGREGATE SHAPE TEST (FLAKINESS & ELONGATION)****FLAKINESS INDEX**

AIM: To find the flakiness index of the given aggregate sample.

APPARATUS:

The apparatus consists of a standard thickness gauge shown in Figure 15.1, IS sieves of sizes 63,50,40,31.5,25,20,16,12.5,10 and 6.3 mm and a balance to weigh the samples.

PROCEDURE:

The sample is sieve with the sieves mentioned in Table 1. A minimum of 200 pieces of each fraction to be tested are taken and weighed = W_1 g. In order to separate flaky materials, each fraction is then gauged for thickness on a thickness gauge shown in Fig. 15.1 or in bulk on sieves having elongated slots. The width of the slot should be of the dimensions specified in column (3) of Table 15.1 for the appropriate size of material. The amount of flaky material passing the gauge is weighed to an accuracy of at least 0.1 percent of the test sample.

TABLE .1

Dimensions of Thickness and Length Gauges

Size of aggregate		(a) Thickness gauge (0.6 times the mean sieve), mm	(b) Length gauge (1.8 times the mean sieve), mm
Passing through IS sieve mm	Retained on IS sieve, mm		
1	2	3	4
63.0	50.0	33.90	-
50.0	40.0	27.00	81.0
40.0	25.0	19.50	58.5
31.5	25.0	16.95	-



25.0	20.0	13.50	40.5
20.0	16.0	10.80	32.4
16.0	12.5	08.55	25.6
12.5	10.0	06.75	20.2
10.0	06.3	04.89	14.7

CALCULATION AND RESULT:

In order to calculate the flakiness index of the entire sample of aggregates first the weight of each fraction of aggregate passing and retained on the specified set of sieves is noted. As an example let 200 pieces of the aggregate passing 50 mm sieve and retained on 50 mm sieve be = W_1 g. Each of the particles from this fraction of aggregate is tried to be passed through the slot of the specified thickness of the thickness gauge; in this example the width of the appropriate gauge of the thickness gauge is 27.0 mm gauge.

Let the weight of the flaky material passing this gauge be W_1 g. Similarly the weights of the fractions passing and retained the specified sieves, $W_1, W_2, W_3,$ etc., are weighed and the total weight $W_1 + W_2 + W_3 + \dots = W$ g is found. Also the weights of materials passing each of the specified thickness gauge are found = W_1, W_2, W_3, \dots and the total weight of material passing the different thickness gauges = $W_1 + W_2 + W_3 + \dots = W$ g is found. Then the flakiness index is the total weight of the flaky material passing the various thickness gauges expressed as a percentage of the total weight of the sample gauged.

$$\text{Flakiness Index} = \frac{(w_1 + w_2 + w_3 + \dots)}{W_1 + W_2 + W_3 + \dots} \times 100 \text{ percent} = 100w \text{ percent}$$



ELONGATION INDEX

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

APPARATUS

The apparatus consists of the length gauge shown in Figure 15.2, sieves of the sizes specified in Table 15.1 and a balance.

PROCEDURE

The sample is sieved through the IS sieves specified in Table 15.1. A minimum of 200 pieces of each fraction is taken and weighed. In order to separate elongated material, each fraction is then gauged individually for length in a length gauge (see fig. 15.2). The gauge length used should be those specified in column 4 of the Table for the appropriate material. The pieces of aggregates from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and are collected separately to find the total weight of aggregate retained on the length gauge from each fraction. The total amounts of elongated material retained by the length gauge are weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

CALCULATION AND RESULT

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 W_1 g. Each piece of these are tried to be passed through the specified gauge length of length gauge, which in this example is $(40+25)/2 \times 1.8 = 58.5$ mm with its longest side and those elongated pieces which do not pass the gauge are separated and the total weight determined = w_1 g.



Similarly the weight of each fraction of aggregate passing and retaining on specified sieves sizes are found, W_1, W_2, W_3, \dots and the total weight sample determined = $W_1 + W_2 + W_3 + \dots = W_g =$. Also the weight of material from each fraction retained on the specified gauge length are found = x_1, x_2, x_3, \dots and the total weight retained determined = $x_1 + x_2 + x_3 + \dots = X \text{ g.}$

The elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged.

$$\text{Elongation Index} = \frac{(x_1 + x_2 + x_3)}{W_1 + W_2 + W_3 + \dots} \times 100 = 100 X \text{ percent}$$



HIGHWAY MATERIALS LAB - BITUMINOUS MATERIALS TESTING

EXPERIMENT 1

PENETRATION TEST

AIM: To find the grade of given bituminous material.

APPARATUS:

It consists of items like container, needle, water bath, penetrometer, stop watch etc.

PROCEDURE:

The bitumen is softened to a pouring consistency between 75⁰ and 100⁰ C above the approximate temperature at which bitumen softens. The sample material is thoroughly stirred to make it homogenous and free from air bubbles and water. The sample material is then poured into the container to a depth at least 15 mm more than the expected penetration. The sample containers are cooled in atmosphere of temperature not lower than 13⁰C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25⁰ C for a period of one hour.

The sample container is placed in the transfer tray with water from the water bath and placed under the needle of the penetrometer. The weight of needle, shaft and additional weight are checked. The total weight of this assembly should be 100g. Using the adjusting screw, the needle assembly is lowered and the tip of the needle is made to just touch the top surface of the sample; the needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle. The initial reading of the penetrometer dial is either adjusted to zero or the initial reading is taken before releasing the needle. The needle is released exactly for a period of 5.0 sec 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 25⁰ C. The test is repeated with sample in the other containers.

Results

The difference between the initial and final penetration readings is taken as the penetration value. The mean value of three penetration measurements is reported as the penetration value. It is further specified by ISI that results of each measurement should not vary from the mean value reported below by more than the following:

Penetration grade	Repeatability
0-80	4 percent
80-225	5 percent
Above 225	7 percent

Observations:

Sample	Penetration Value
1	
2	
3	

APPLICATIONS OF PENETRATION TEST:

Penetration test is the most commonly adopted test on bitumen to grade the material in terms of its hardness. Depending up to the climatic condition and type of construction, bitumen of different penetration grades are used, 80/10 bitumen denotes that the penetration value ranges between 80 and 100. The penetration values of various types of bitumen used in pavement construction in this country range between 0 and 225. For bituminous macadam and penetration macadam Indian Roads Congress suggests bitumen grades 30/40, 60/70 and 80/100. In warmer regions lower penetration grades from preferred and in colder regions bitumen with higher penetration values are used.



The penetration test is not intended to estimate the consistency of softer materials like cutback or tar, which are usually graded by a viscosity test in an orifice viscometer.

The India Standards Institution has classified paving bitumen available in this country into the following six categories depending on the penetration values. Grades designated 'A' (such as A 35) are from Assam Petroleum and those designated 'S' (such as S 35) are from other sources.

Bitumen grade	A 25	A 35 & S 35	A 45 & S 45	A 65 & S 65	A 90 & S 90	A 200 & S 200
Penetration Value	20 to 30	30 to 40	40 to 50	60 to 70	80 to 100	175 to 225



EXPERIMENT 2

Ductility Test

AIM: To find the ductility value of the given bituminous material

APPARATUS:

The ductility test apparatus consists of items like sample (briquette) moulds, water bath square-end trowel or putty knife sharpened on end and ductility machine.

(a) Briquette mould: Mould is made of brass metal with shape and dimensions as indicated. Both ends called clips possess circular holes to grip the fixed and movable ends of the testing 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 x 10 mm

(b) Ductility machine: It is 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° C to 100° 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 glycerin and dextrin 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 along with the sample is placed in water bath maintained at 27⁰ C for 30 minutes. The sample and mould assembly is removed from water bath and leveling the surface using hot knife cuts off excess bitumen material. After trimming the specimen, the mould assembly-containing sample is replaced in water bath maintained at 27⁰ C for 85 to 90 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.

RESULT

The distance stretched by the moving end of the specimen up to the point of breaking of thread measured in centimeters is recorded as ductility 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 for various types of bituminous pavement. Often a minimum ductility value of 50 cm is specified for bituminous construction.

The minimum ductility values specified by the Indian Standards Institutions for various grades bitumen available in India are given below:



Sources of paving bitumen and penetration grade	Minimum ductility value, cm
Assam Petroleum A 25	5
Assam Petroleum A 35	10
Assam Petroleum A 45	12
Assam Petroleum A 65, A 90 & A 200	15
Bituminous from sources other than	
Assam Petroleum S 35	50
S 45, S 65 & S 90	75



EXPERIMENT 3

SOFTENING POINT TEST

AIM: To find the softening point of the given Bituminous material

APPARATUS

It consists of Ring and Ball apparatus

(a) Steel Balls: They are two in number. Each has a diameter of 9.5 mm and weight $2.5 \pm .05$ g.

(b) 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

Brass rings are also placed with ball guides as shown in Fig. 19.2

(c) Support: The metallic support is used for placing pair of rings.

The upper surface of the rings is adjusted to be 50 mm below the surface of water or liquid contained in the bath. A distance of 25 mm between the bottom of the rings and top surface of the bottom plate of supported is provided. It has a housing for a suitable thermometer.

(d) Bath and stirrer: A heat resistant glass container of 85 mm diameter and 120 mm depth is used. Bath liquid is water for material having softening point below 80° C and glycerin for materials having softening point above 80° C. Mechanical stirrer is used for ensuring uniform heat distribution at all times throughout the bath.



PROCEDURE

Sample material is heated to a temperature between 75°C and 100°C above the approximate softening point until it is completely fluid and is poured in heated rings placed on metal plate. To avoid sticking of the bitumen to metal plate, coating is done 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, 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 as a heating medium and the starting temperature is 35° C instead of 5°C.

RESULTS

Softening Point value of bitumen =

The temperature at the instant when each of the ball and sample touches the bottom plate of support is recorded as softening value. The mean of duplicate determinations is noted. It is essential that the mean value of the softening point (temperature) does not differ from individual observations by more than the following limits.

<i>Softening Point</i>	<i>Repeatability</i>	<i>Reproducibility</i>
Below 30° C	2° C	4° C
30° C to 80° C	1° C	2° C
Above 80° C	2° C	4° C



APPLICATIONS OF SOFTENING POINT TEST

Softening Point is essentially the temperature at which the bituminous binders have an equal viscosity. The softening point of tar is therefore related to the *equi-viscous temperature* (e.v.t.). The softening point found by the ring and ball apparatus is approximately 20⁰ C lower than the e.v.t.

Softening point, thus gives an idea of the temperature at which the bituminous material attains a certain viscosity. Bitumen with higher softening point may be preferred in warmer place. Softening point is also sometimes used to specify hard bitumen and pitches.

The ranges of softening point specified by the Indian Standard Institution for various grades of bitumen are given below:

Bitumen Grades	Softening Point , °C
* A 25 & A 35	55 to 70
* S 35	50 to 65
A 45 , S 45 & A 65	45 to 60
S 65	40 to 55
A 90 & S 90	35 to 50
A 200 & 200	30 to 45

* 'A' denotes bitumen from Assam Petroleum and 'S' denotes bitumen from sources other than from Assam Petroleum. Also see Table under 'Application of penetration test'.



EXPERIMENT 4

FLASH AND FIRE POINT TEST

AIM: To find flash and fire point of given bituminous material.

APPARATUS:

Pensky - martens closed tester consists of cup, lid, stirring device, cover, shutter, and flame exposure device.

PROCEDURE:

All parts of the cup are cleaned and dried thoroughly before the test is started. The material is filled in the cup up to a filling 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 bead is of 4 mm diameter. The heating is done at the rate of 5⁰ to 6⁰ C per minute. 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. First application is made at least 17⁰ C below the actual flash point and then at every 1⁰ to 3⁰ C, the stirring discontinued during the application of the test flame.

RESULTS:

Flash point of bitumen =

Fire point of bitumen =

The flash point is taken as the temperature read on the thermometer at the time of the flame application that causes a bright flash in the interior of the cup in closed system. For open cup it is the instance when flash appears first at any point on the surface of the material. The heating is continued until the volatile ignite and the material continues to burn for 5 seconds. The temperature of the sample material when this occurs is recorded as the fire point.



APPLICATION OF TEST:

Different bituminous materials have quite different values of flash and fire points. When the bitumen or cutback is to be heated before mixing or application, utmost care is taken to see that heating is limited to a temperature well below the flash point. This is essential from safety point of view.

The minimum value of flash point by Pensky martens closed type apparatus specified by the ISI is 175°C for all the grades of bitumen.

The minimum specified flash point for rapid curing cutback bitumen of all grades is 26°C and that for medium curing type is 38°C for grades 0 and I and 65°C for grades 2 to 5. Slow curing cutbacks have minimum values ranging from 65°C to 121°C .