

Department of Civil Engineering

Concrete & Highway Materials Laboratory

18CVL47

B.E - IV Semester

Laboratory Manual 2019-20

Name: _____

USN: _____

Batch: _____ Section: _____

Dr AIT

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Department of Civil Engineering

Concrete & Highway Materials Laboratory

18CVL47

SYLLABUS

Subject code	**: 18CVL47**	**IA Marks**	**: 25**
No. of Practical Hours	**: 03**	**Exam Hours**	**: 03**
Total No of Practical Hours	**: 42**	**Exam Marks**	**: 50**

CEMENT:

Normal Consistency of cement
Setting time of cement
Soundness by Autoclave method
Compression strength test
Air permeability test of cement for fineness
Specific gravity of cement.

FRESH CONCRETE:

Workability – slump test
Compaction factor test
Vee- Bee test

HARDENED CONCRETE:

Compression strength
Split tensile test
Flexural strength of RCC beams
Permeability of concrete

SOIL:

CBR test

AGGREGATES:

Crushing test
Abrasion test
Impact test
Shape tests (Flaky, Elongation, and Angularity number)
Specific gravity

BITUMINOUS MATERIALS AND MIXES:

Specific Gravity
Penetration test
Ductility test
Softening point of bitumen.
Flash and fire point
Viscosity
Marshall Stability test

Dr AIT

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Note:

Sl. No	Name of the Experiment	Date			Manual Marks(Max.25)	Record Marks(Max.10)	Signature(Student)	Signature(Faculty)
		Conduction	Repetition	Submission of Record				
Average								

- **Note: If the student fails to attend the regular lab, the experiment has to be completed in the same week. Then the manual/observation and record will be evaluated for 50% of maximum marks.**

DEPARTMENT OF CIVIL ENGINEERING

Course objectives

- The objective of concrete laboratory is to determine the physical properties of building construction materials like cement, fine and coarse aggregate. The tests include determination of specific gravity, fineness, normal consistency, setting times, workability and soundness of cement, fineness modulus of fine and coarse aggregate, strength of cement mortar, cement concrete. Students can design the mix, make the specimens and test the same for their respective strengths.

- The objective of highway materials laboratory is to determine some of the properties of coarse aggregates and bitumen. Experiments include tests for impact, abrasion and crushing strength for coarse aggregates. For bitumen, tests include penetration, ductility, viscosity, softening point and flash and fire point. The students will be able to infer the suitability of these materials for construction of road. This laboratory course will help the students to understand the theoretical concepts learned in the course transportation engineering

Course outcome

- Students at the end of the course will be able to test all the concrete materials as per IS code, design of the concrete mix using IS code, determine the properties of fresh and hardened concrete, measure the physical properties of the bitumen.

‘Instructions to the Candidates’

1. **Students should come with thorough preparation for the experiment to be conducted.**

2. **Students will not be permitted to attend the laboratory unless they bring the practical record fully completed in all respects pertaining to the experiment conducted in the previous class.**

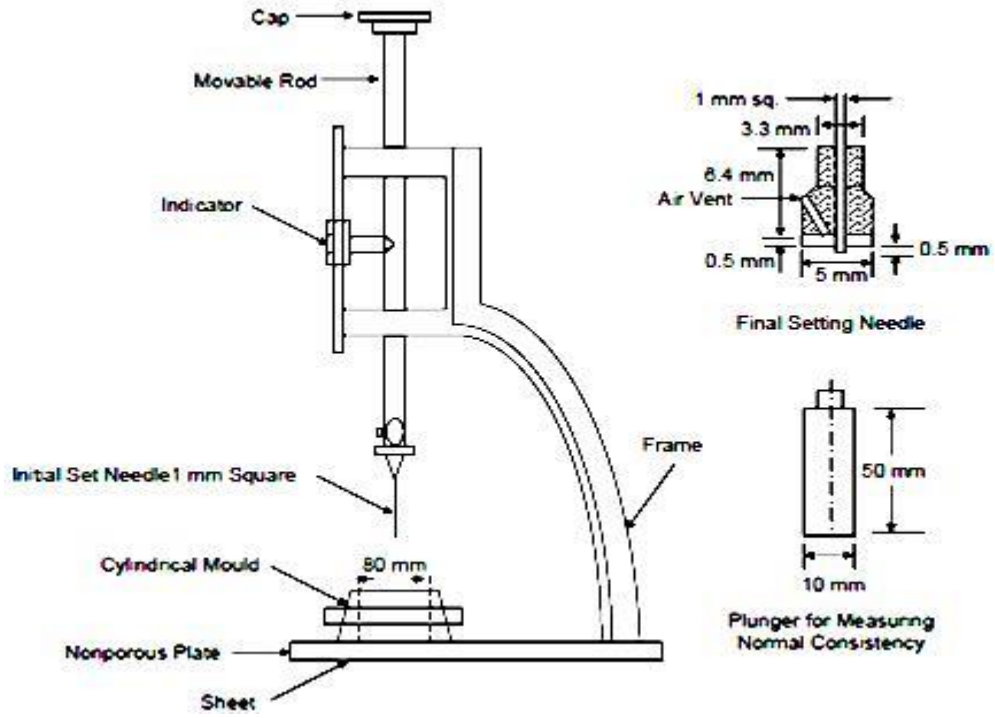
3. **All the calculations should be made in the observation book. Specimen calculations for one set of readings have to be shown in the practical record.**

4. **Wherever graphs are to be drawn, A-4 size graphs only should be used and the same should be firmly attached to the practical record.**

5. **Practical record should be neatly maintained.**

6. **They should obtain the signature of the staff-in-charge in the observation book after completing each experiment.**

7. **Theory regarding each experiment should be written in the practical record before procedure in your own words.**



VICAT APPARATUS

OBSERVATIONS:

S. No	Weight of cement taken in gms (a)	Weight of water taken in gms (b)	Plunger penetration (mm)	Consistency of cement in % by weight b/a * 100

NORMAL CONSISTENCY OF CEMENT

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

APPARATUS: Vicat apparatus (conforming to IS: 5513 - 1976) with plunger (10 mm in diameter) balance, weights, gauging trowel.

THEORY: The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicatmould. For finding out initial setting time, final setting time, soundness of cement and compressive strength of cement, it is necessary to fix the quantity of water to be mixed in cement in each case. This experiment is intended to find out the quantity of water to be mixed for a given cement to give a cement paste of normal consistency and can be done with the help of vicat apparatus.

PROCEDURE:

1. Prepare a paste of weighed quantity of cement (300 grams) with a weighed quantity of potable or distilled water, starting with 26% water of 300g of cement.
2. Take care that the time of gauging is not less than 3 minutes, not more than 5 minutes and thegauging shall be completed before setting occurs.
3. The gauging time shall be counted from the time of adding the water to the dry cement untilcommencing to fill the mould.
4. Fill the vicatmould with this paste, the mould resting upon a non porous plate.
5. After completely filling the mould, trim off the surface of the paste, making it in level with the top of the mould. The mould may slightly be shaken to expel the air.
6. Place the test block with the mould, together with the non-porous resting plate, under the rod bearing the plunger (10mm diameter), lower the plunger gently to touch the surface of the test block and quickly release, allowing it to penetrate into the paste.
7. This operation shall be carried out immediately after filling the mould.
8. Prepare trial pastes with varying percentages of water and test as described above until the amount of water necessary for making the standard consistency as defined above is obtained
9. Express the amount of water as a percentage by weight of the dry cement.

PRECAUTIONS:

Clean appliances shall be used for gauging. In filling the mould the operator hands and the blade of the gauging trowel shall alone be used. The temperature of cement, water and that of test room, at the time when the above operations are being performed, shall be 27 + 2 C. For each repetition of the experiment fresh cement is to be taken.

RESULT: Normal consistency for the given sample of cement is……..

COMMENTS:

INITIAL AND FINAL SETTING TIMES OF CEMENT

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

APPARATUS: Vicat apparatus (conforming to IS: 5513-1976) with attachments, balance, weights, gauging trowel.

INTRODUCTION: In actual construction dealing with cement, mortar or concrete, certain time is required for mixing, transporting and placing. During this time cement paste, mortar, or concrete should be in plastic condition. The time interval for which the cement products remain in plastic condition is known as the setting time. Initial setting time is regarded as the time elapsed between the moments that the water is added to the cement to the time that the paste starts losing its plasticity. The final setting time is the time elapsed between the moment the water is added to the cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain pressure. The constituents and fineness of cement is maintained in such a way that the concrete remains in plastic condition for certain minimum time. Once the concrete is placed in the final position, compacted and finished it should lose its plasticity in the earliest possible time so that it is least vulnerable to damages from external destructive agencies. This time should not be more than 10 hours which is referred to as final setting time. Initial setting time should not be less than 30 minutes.

PROCEDURE:

Preparation of Test Block:

1. Prepare a neat cement paste by gauging 300 grams of cement with 0.85 times the water required to give a paste of standard consistency.

2. Potable or distilled water shall be used in preparing the paste.

3. The paste shall be gauged in the manner and under the conditions prescribed in determination of consistency of standard cement paste.

4. Start a stop-watch at the instant when water is added to the cement.

5. Fill the mould with the cement paste gauged as above the mould resting on a nonporous plate.

6.Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould. The cement block thus prepared in the mould is the test block

OBSERVATIONS

Time in minutes				
Height in mm fails to penetrate				

DETERMINATION OF INITIAL SETTING TIME:

1. Place the test blocks confined in the mould and rest it on the non-porous plate, under the rod bearing initial setting 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.
2. In the beginning, the needle will completely pierce the test block.
3. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block to a point 5 to 7 mm measured from the bottom of the mould shall be the initial setting time.

DETERMINATION OF FINAL SETTING TIME:

1. Replace the needle of the Vicat apparatus by the needle with an annular attachment.
2. The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression there on, while the attachment fails to do so.
3. The period elapsed between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so shall be the final setting time.

PRECAUTIONS: Clean appliances shall be used for gauging. All the apparatus shall be free from vibration during the test. The temperature of water and that of the test room, at the time of gauging shall be 27 C + 2 C. Care shall be taken to keep the needle straight.

RESULT: Initial setting time for the given sample of cement
= Final setting time for the given sample of cement =

COMMENTS:



Specific Gravity Bottle

OBSERVATIONS

Description of item	Trial 1	Trial 2	Trial 3
Weight of empty bottle W1 g			
Weight of bottle + Cement W2 g			
Weight of bottle + Cement + Kerosene W3 g			
Weight of bottle + Full Kerosene W4 g			
Weight of bottle + Full Water W5 g			

Specific gravity of Kerosene $Sk = W_4 - W_1 / W_5 - W_1$ ……

Specific gravity of Cement $Sc = W_2 - W_1 / ((W4 - W1)-(W_3-W_2))*Sk$…….

$Sc = (W_2 - W_1)* (W_4 - W1) / ((W_4 - W_1)-(W_3-W_2))*(W_5 - W_1)$…….

SPECIFIC GRAVITY OF CEMENT

AIM: To determine the specific gravity of given sample of cement.

APPARATUS: Physical balance, specific gravity bottle of 50ml capacity, cleans kerosene.

INTRODUCTION: Specific gravity is defined as the ratio between weight of a given volume of material and weight of an equal volume of water. To determine the specific gravity of cement, kerosene is used which does not react with cement.

PROCEDURE:

1. Clean and dry the specific gravity bottle and weigh it with the stopper (W_1).
2. Fill the specific gravity bottle with cement sample at least half of the bottle and weigh with stopper (W_2).
3. Fill the specific gravity bottle containing the cement, with kerosene (free of water) placing the stopper and weigh it (W_3).
4. While doing the above do not allow any air bubbles to remain in the specific gravity bottle.
5. After weighing the bottle, the bottle shall be cleaned and dried again.
6. Then fill it with fresh kerosene and weigh it with stopper (W_4).
7. Remove the kerosene from the bottle and fill it with full of water and weigh it with stopper (W_5).
8. All the above weighing should be done at the room temperature of 27 ^{0}C $\pm$ 1^{0}C.

PRECAUTIONS

1. Only kerosene which is free of water shall be used.
2. At time of weighing the temperature of the apparatus will not be allowed to exceed the specified temperature.
3. All air bubbles shall be eliminated in filling the apparatus and inserting the stopper.
4. Weighing shall be done quickly after filling the apparatus and shall be accurate to 0.1 mg.
5. Precautions shall be taken to prevent expansion and overflow of the contents resulting from the heat of the hand when wiping the surface of the apparatus.

RESULT: Average specific gravity of given sample of cement =

COMMENTS



Autoclave Apparatus

OBSERVATION

Type of Cement Tested	
Initial Length Of The Specimen L_1	
Final Length Of The Specimen L_2	
Expansion Of The Specimen (L_1- L_2)	

CALCULATION

Soundness of cement=L_1-L_2,

Where,

L_1=Length measured after curing for a period of 24 hrs in a moist room.

L_2=Length measured after completion of autoclave test.

A contraction (negative expansion) is indicated by prefixing a (–) sign to the percentage expansion reported.

SOUNDNESS OF CEMENT

AIM: To determine the soundness of the given sample of cement by "Autoclave" Method.

APPARATUS: Autoclave apparatus, Balance, Weights, Water bath. Measuring cylinder, Length comparator, Trowel

INTRODUCTION In the soundness test a specimen of hardened cement paste is boiled for a fixed time so that any tendency to expand is speeded up and can be detected. Soundness means the ability to resist volume expansion

PROCEDURE

1. Thinly cover the mould with mineral oil. Then attach the reference points so as to get an effective length of 250 mm.
2. Take 500 g of cement and mix with sufficient water to give a paste of standard consistency.
3. After mixing fill the mould in one or two layers by pressing the paste into corners by thumb. Smoothen the top layer by trowel.
4. After completion of preparation of the mould, store it in a moist room for a period of 24 hours.
5. After 24 ± ½ hrs after moulding, remove the specimen from the moist atmosphere, measure its length (L_1) and place it in the autoclave at room temperature in a rack so that the four sides of each specimen is exposed to saturated steam vapour during the entire period of test.
6. To permit air to escape from the autoclave during the early portion of the heating period, left the vent valve open until steam begins to escape.
7. Then close the vent valve and raise the temp of the autoclave at such a rate, so as to make the gauge pressure of the steam to 2.1 N/mm^2 in 1 to 1.5 hrs from the time heat turned on. This pressure is maintained for 3 hrs.
8. After 3 hrs switch off the autoclave, and let it be cooled at the rate so as to make the pressure less than 0.1 N/mm^2 in one hour and bring it to atmospheric pressure by opening vent valve.
9. Then remove the specimen from autoclave and place it in water maintained at a temp of 900^0C. Then cool the water to 27 ± 2^0C in 15 minutes. Dry the surface of the specimen and measure its length (L_2).

Note: In the event of cement failing to comply with the specified requirements, a further test should be made from another portion of the same sample in manner described above, but after **aeration** (done by spreading out to a depth of 75 mm at a relative humidity of 50 to 80% for a total period of 7 days)

RESULT: Expansion in mm

COMMENT

LE CHATELIER METHOD (IS:4031-Part 3-1988)

APPARTUS: Le-chatelier apparatus, Water bath, Caliper, Measuring cylinder, Balance.

PROCEDURE:

1. Before commencing setting time test, do the consistency test to obtain the water required to give the paste normal consistency (P).
2. Prepare a paste of 50gms of cement by adding 0.78 times the water required to give a paste of standard consistency (i.e. 0.78P).

3. Lightly oil the Le-chatelier mould and place it on a lightly oiled glass sheet.
4. Fill the mould with the prepared cement paste. In the process of filling the mould keep the edge of the mould gently together.
5. Cover the mould with another piece of lightly oiled glass sheet; place a small weight on this covering glass sheet.
6. Submerge the whole assembly in water at a temperature of 27 ± 2^0 C and keep there for 24 Hours.
7.Remove the whole assembly from water bath and measure the distance separating the indicator points to the nearest 0.5 mm (L_1).
8. Again submerge the whole assembly in water bath and bring the temperature of water bath to boiling temperature in 25 to 30 minutes. Keep it at boiling temperature for a period of 3 hours.
9. After completion of 3 hours, allow the temperature of the water bath to cool down to room temperature and remove the whole assembly from the water bath.
10. Measure the distance between the two indicator points to the nearest 0.5 mm (L_2).

CALCULATIONS:

Soundness/expansion of cement = L_1-L_2

L_1 = Measurement taken after 24 hours of immersion in water at a temp. of 27 ± 2^0 C

L_2 = Measurement taken after 3 hours of immersion in water at boiling temperature.

Calculate the mean of two values to the nearest 0.5 mm.

RESULT:

CONCLUSION



Compression Strength Machine

CALCULATION:

Calculate the compressive strength from the crushing load and the average area over which the load is applied. Express the results in N/mm^2 to the nearest 0.05 mm^2. Compressive strength in N/mm^2 = P/A =

Where P is the crushing load in N and A is the area in mm^2 (5000 mm^2)

COMPRESSIVE STRENGTH OF CEMENT

AIM: To determine the compressive strength of standard cement mortar cubes compacted by means of standard vibration machine.

APPARATUS: Vibration machine and cube moulds of size 7.06 cms (Conforming to IS: 4031 1988)

STANDARD SAND: The standard sand to be used in the test shall conform to IS: 650-1991 or sand passing 100 percent through 2 mm sieve and retained 100 percent on 90 micron IS sieve.

2mm to 1mm	33.33 percent
1mm to 500 microns	33.33 percent
500mm to 90 microns	33.33 percent

INTRODUCTION: The compressive strength of cement mortars is determined in order to verify whether the cement conforms to IS specifications and whether it will be able to develop the required compressive strength of concrete. The average compressive strength of at least three mortar cubes (area of the face 50 cm^2) composed of one part of cement and three parts of standard stand should satisfy IS code specifications.

PROCEDURE:

Mix proportions and mixing:

1. Clean appliances shall be used for mixing and the temperature of the water and that of the test room at the time when the above operations are being performed shall be $27^0 + 2^0$C.

2. Place in a container a mixture of cement and standard sand in the proportion of 1:3 by weight mix it dry, with a trowel for one minute and then with water until the mixture is of uniform color.

3. The quantity of water to be used shall be as specified below.

4. In any element, it should not take more than 4 minutes to obtain uniform colored mix.

5. If it exceeds 4 minutes the mixture shall be rejected and the operation repeated with a fresh quantity of cement, sand and water.

6. The material for each cube shall be mixed separately and the quantity of cement standard sand and water shall be as follows:

Cement	200grms
Standard sand	600 grms
Water	(P/4 + 3.0) percent of combined weight of cement and sand, where p is the percentage of water required to produce a paste of standard consistency.

MOULDING SPECIMENS:

1. In assembling the moulds ready for use, cover the joints between the halves of the mouldwith a thin film of petroleum jelly and apply a similar coating of petroleum jelly between the contact surfaces of the bottom of the mould and its base plate in order to ensure that no water escapes during vibration.
2. Treat the interior faces of the mould with a thin coating of mould oil.
3. Place the assembled mould on the table of the vibration machine and firmly hold it is position by means of suitable clamps.
4. Securely attach a hopper of suitable size and shape at the top of the mould to facilitate filling and this hopper shall not be removed until completion of the vibration period.
5. Immediately after mixing the mortar, place the mortar in the cube mould and rod with a rod.
6. The mortar shall be rodded 20 times in about 8 seconds to ensure elimination of entrainedair and honey combing.
7. Place the remaining quantity of mortar in the hopper of the cube mould and rod again as specified for the first layer and then compact the mortar by vibrations.
8. The period of vibration shall be two minutes at the specified speed of 12,000 + 400 vibrations per minute.
9. At the end of vibration remove the mould together with the base plate from the machine and finish the top surface of the cube in the mould by smoothing surface with the blade ofa trowel.

CURING SPECIMEN:

1. Keep the filled moulds at a temperature of $27^0 + 20^0$ C in an atmosphere of at least 90 % relative humidity for about 24 hours after completion of vibration.
2. At the end of that period remove them from the moulds.
3. Immediately submerge in clean fresh water and keep them under water until testing.
4. The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of 27^0C + 2^0C.
5. After they have been taken out and until they are tested the cubes shall not be allowed to became dry.

TESTING:

1. Test three cubes for compressive strength at the periods mentioned under the relevant specification for different hydraulic cements, the periods being reckoned from the completion of vibration.

2. The compressive strength shall be the average of the strengths of three cubes for each period of curing.

3. The cubes shall be tested on their sides without any packing between the cube and the steel plates of the testing machine.

4. One of the platens shall be carried base and shall be self-adjusting and the load shall be steadily and uniformly applied starting from zero at a rate of 350 Kgs/Cm^2/ min.

Ordinary portland cement	3, 7 and 28 days.
Rapid hardening portland cement	1 and 3 days.
Low heat portland cement	3 and 7 days.

PRECAUTIONS: Inside of the cube moulds should be oiled to prevent the mortar fromadhering to the sides of the mould.

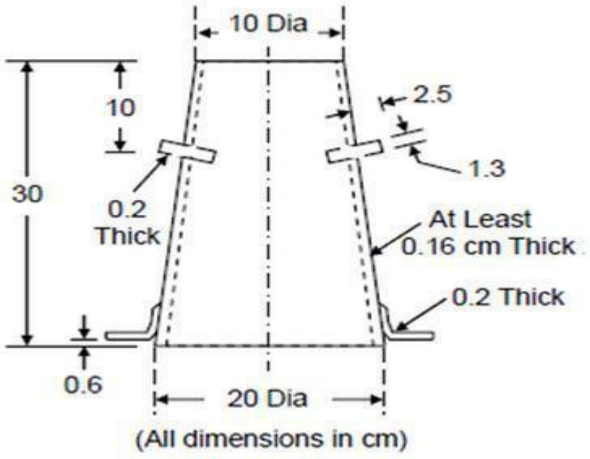
RESULT: The average compressive strength of the given cement

at 3 days ……. N/mm^2

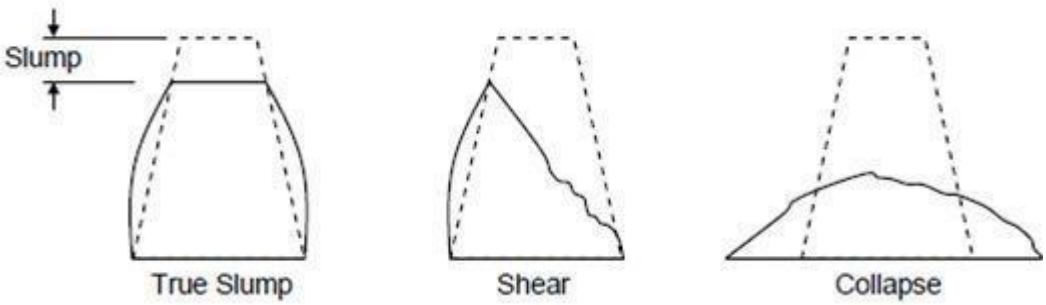
at 7 days…….. N/mm^2

at 28 days…… N/mm^2

COMMENTS:



Slump Cone



Different Types of Slump

OBSERVATIONS

Sl No	W/C ratio	Slump in mm
1	0.5	
2	0.6	
3	0.7	
4	0.8	

WORKABILITY TESTS ON FRESH CONCRETE
SLUMP TEST

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

APPARATUS: Iron pan to mix concrete, weighing machine, trowel slump, cone, scale and Tamping rod

The slump cone is a hollow frustum made of thin steel sheet with internal dimensions, as the top diameter 10 cms. The bottom diameter 20 cms, and height 30cms. It stands on a plane non-porous **s**urface. To facilitate vertical lifting from moulded concrete it is provided with a suitable guide attachment and suitable foot pieces and handles. The tamping rod is 16mm. dia. 60 cm. 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 heightwill take place. This vertical settlement is called slump. Slump is a measure 0.5, 0.6, 0.7 and 0.8. For eachmix take 10 Kg. C.A., 5 Kg., FA and 2.5 Kg. Cement.

PROCEDURE

1. Mix the dry constituents thoroughly to get a uniform colour and then add water.
2. The internal surface of the mould is to be thoroughly cleaned and placed on a smooth, horizontal, rigid and nonabsorbent surface.
3. Place the mixed concrete in the cleaned slump cone in 4 layers each approximately 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 subsistence of the concrete in cms, which gives the slump.

Note: Slump test is adopted in the Laboratory or during the progress of the work in the field for determining consistency of concrete where nominal max., size of aggregates does not exceed 40 mm. Any slump specimen which collapses or shears off laterally gives incorrect results and at this juncture the test is repeated only true slump should be measured.

PRECAUTIONS:

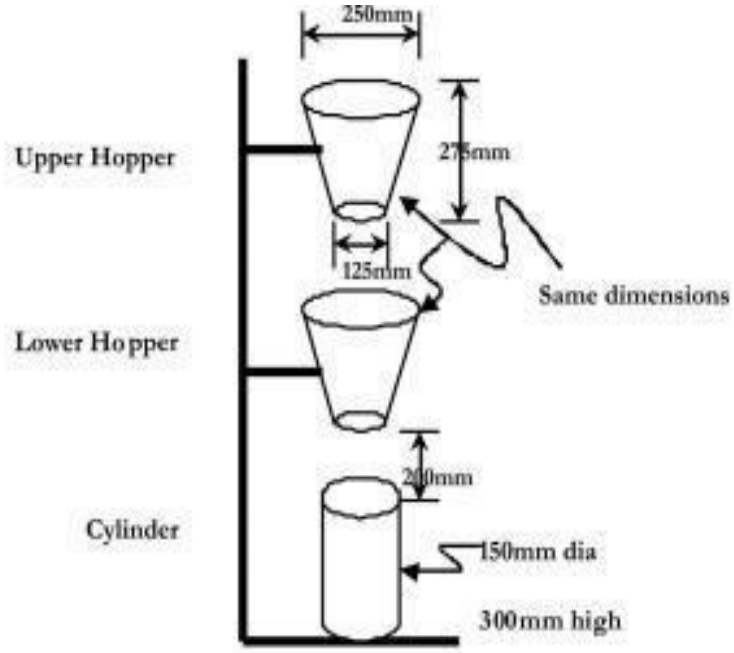
1. The strokes are to be uniformly applied through the entire area of the concrete section.
2. The cone should be removed very slowly by lifting it upwards without disturbing the concrete.
3. During filling the mould must be firmly pressed against the base.
4. Vibrations from nearly machinery might also increase subsidence; hence test should be made beyond the range of ground vibrations.

RESULT

COMMENTS: This test is not a true guide to workability. For example, a harsh coarse mix cannot be said to have same workability as one with a large portion of sand even though they have the same slump.

Recommended slumps of concrete mix of various works

S.No	Description of work	Recommended slump in cms
1	Road work	2.5 to 5.0
2	Ordinary beams to slabs|	5 to 10
3	Columns thin vertical section & retaining Walls etc	7.5 to 12.5
4	Mass concrete(Runway, |Pavements)	2.5 to 5



Compaction Factor Apparatus

OBSERVATIONS AND CALCULATIONS:

Weight of cylinder = W_1Kgs.

S.No	W/c ration	Wt. With partially compaction W_2 (Kgs)	Wt. With fully compaction W_3 (Kgs)	Wt. With partially compacted concrete(W_2- W_3) (Kgs)	Wt. With fully compacted concrete(W_3- W_1) (Kgs)	Compaction factor (W_1- W_2)/ (W_3- W_1)
1	0.5					
2	0.6					
3	0.7					
40.8						

COMPACTION FACTOR TEST

AIM: To determine the consistency (workability) of freshly mixed concrete.

APPARATUS: Compaction factor apparatus, balance, tamping rod

THEORY: This test is adopted to determine workability of concrete where nominal size of aggregate does not exceed 40 mm. It is based on the definition, that workability is that property of concrete, which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction.

The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall be stated to the nearest second decimal place.

PROCEDURE: Conduct test for W/c ratio 0.5, 0.6, 0.7, and 0.8, for each mix take 10 kg of coarse aggregate 5kg of fine aggregate and 2.5 Kg of cement.

1. Grease the inner surface of the hoppers and the cylinder.
2. Fasten the hopper doors.
3. Weigh the empty cylinder accurately (W_1. Kgs).
4. Fix the cylinder on the base with fly nuts and bolts
5. Mix coarse and fine aggregates and cement dry until the mixture is uniform in color and then with water until concrete appears to be homogeneous.
6. Fill the freshly mixed concrete in upper hopper gently with trowel without compacting.
7. Release the trap door of the upper hopper and allow the concrete of fall into the lower hopper bringing the concrete into standard compaction.
8. Immediately after the concrete comes to rest, open the trap door of the lower hopper and allow the concrete to fall into the cylinder, bringing the concrete into standard compaction.
9. Remove the excess concrete above the top of the cylinder by a trowel.
10. 10. Find the weight of cylinder i.e cylinder filled with partially compacted concrete (W_2kgs)
11. Refill the cylinder with same sample of concrete in approx. 4 layers, tamping each layerwith tamping for 25 times in order to obtain full compaction of concrete.
12. Level the mix and weigh the cylinder filled with fully compacted concrete (W_3 Kg)
13. Repeat the procedure for different for different a trowel.

PRECAUTIONS:

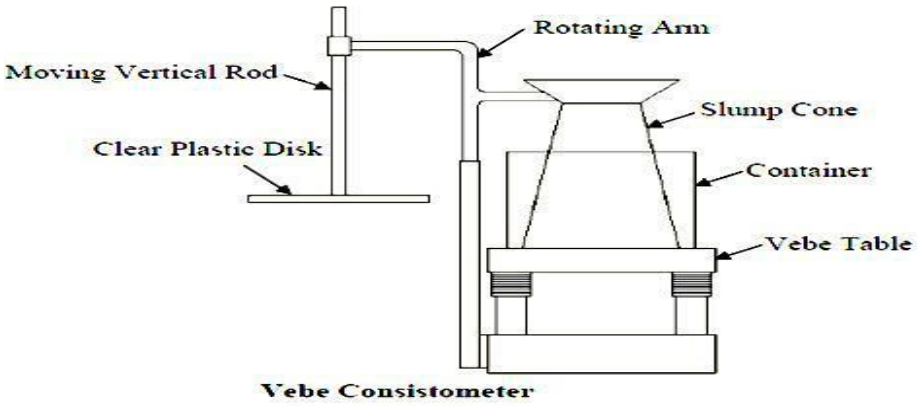
1. The top hopper must be filled gently.
2. The mix should not be pressed or compacted in the hopper.
3. If the concrete in the hopper does not fall through when the trap door is released, it should be freed by passing a metal rod. A single steady penetration will usually affect release.

COMMENTS: It is more sensitive, precise than slump test and is particularly useful to concrete mixes of low workability.

Suggested ranges of values of compaction factors for different placing conditions.

S.No	**Placing condition**	**Degree Of workability**	**Values of workability**
1	Concreting shallow section with vibration	Very low	0.75 to 0.80
2	Concreting of lightly reinforced section with vibration	Low	0.8 to 0.85
3	Concreting of lightly reinforced section without vibration or heavily reinforced with vibration	Medium	0.85 to 0.92
4	Concreting of heavily reinforced section without vibration	High	0.92 to above

RESULT



OBSERVATION

Initial reading on the graduate rod A		
Final reading on the graduate rod B		
Slump B –A		
Time for complete remoulding in sec		

VEE-BEE CONSISTOMETER

AIM: To measure the workability of concrete by vee-bee consistometer test

APPARATUS REQUIRED: Vee-Bee consistometer test apparatus, iron rod, stop watc

THEORY The Veebe consistometer (Bartos 1992; Scanlon 1994; Bartos, Sonebi, and Tamimi 2002) measures the remolding ability of concrete under vibration. The test results reflect the amount of energy required to remold a quantity of concrete under given vibration conditions. The Veebe consistometer is applicable to concrete with slumps less than 5cm

PROCEDURE.

1. Placing the slump cone inside the sheet metal cylindrical pot of the consistometer.
2. The glass disc attached to the swivel arm is turned and placed on the top of the concrete pot.
3. The electrical vibrator is switched on and simultaneously a stop watch is started.
4. The vibration is continued till such a time as the conical shape of the concrete disappears and the concrete assumes cylindrical shape.
5. Immediately when the concrete fully assumes a cylindrical shape, the stop watch is switched off. The time required for the the shape of concrete to change from slump cone shape to cylindrical shape in seconds is known as vee bee degree.

Result: The consistency of the concrete is……sec.

OBSERVATIONS

Sl no	Max load in N	Area of specimen mm^2	Compressive strength N/mm^2
1			
2			
3			

CALCULATION: The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test, by the cross sectional area, calculated from the mean dimensions of section and shall be expressed to the nearest Kg/sq.cm. Average of three values shall be taken as the representative of the batch provided the individual variation is not more than + 15% of the average. Otherwise, repeat tests shall be made.

TEST FOR COMPRESSIVE STRENGTH OF CONCRETE CUBES

AIM: To determination of the compressive strength of given concrete mixes.

APPARATUS: Testing Machine, Specimen mould, tamping rod

SPECIMEN: Cement concrete cubes of size 15cm, prepared from the given cement, fine aggregates & coarse aggregates, water.

THEORY & SIGNIFICANCE: Concrete is very strong in compression. It is assumed that whole of the compression will be taken up by the concrete while designing any RCC structure. The most important strength test for concrete is the compression test. This test is not only important from structural point of view but also other properties such as fatigue, impact, shrinkage, creep, deformation and thermal sensitivity bear some relationship with it.

PROCEDURE.

1. Calculate the material required for preparing the concrete of given proportions (1:2:4).
2. Mix them thoroughly in mechanical mixer until uniform color of concrete is obtained
3. Pour concrete in the oiled with a medium viscosity oil. Fill concrete is cube moulds intwo layers each of approximately 75mm and ramming each layer with 35 blows evenlydistributed over the surface of layer.
4. Fill the moulds in 2 layers each of approximately 50mm deep and ramming each layer heavily.
5. Struck off concrete flush with the top of the moulds.
6. Immediately after being made, they should be covered with wet mats.
7. Specimens are removed from the moulds after 24hrs and cured in water 28 days
8. After 24hrs of casting, cylinder specimens are capped by neat cement paste 35 percent water content on capping apparatus. After 24 hours the specimens are immersed into water for final curing.
9. Compression tests of cube and cylinder specimens are made as soon as practicable after removal from curing pit. Test-specimen during the period of their removal from the curing pit and till testing, are kept moist by a wet blanket covering and tested in a moist condition.
10. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and without shock.
11. Also note the type of failure and appearance cracks.

REPORTING OF RESULTS:

The following information shall be included in the report on each test specimen:

a) Identification mark

b) Date of test

c) Age of specimen

d) Curing conditions including date of manufacture of specimen in the field

e) Weight of specimen

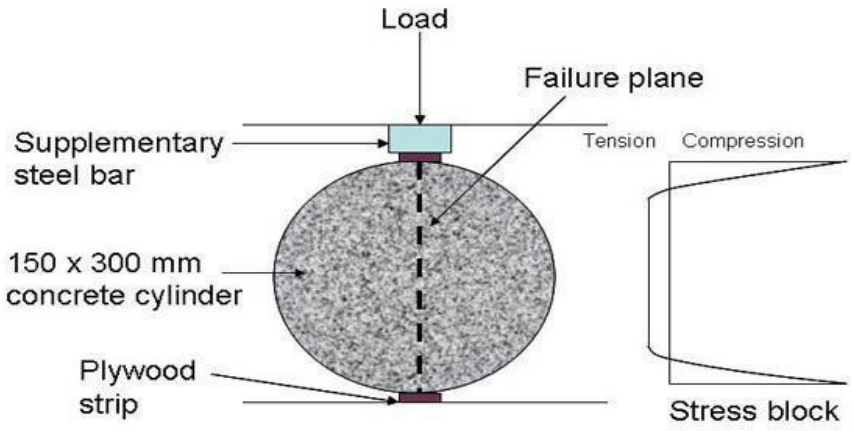
f) Dimensions of specimen

g) Compressive strength

h) Maximum load

RESULT: Compressive strength of Concrete ----------.N/mm^2

COMMENTS



Loading Arrangement for Determining Split Tensile Strength

OBSERVATION

Sl No	Dia of the specimen (mm)	Length of the specimen (mm)	Breaking load (N)	Split tensile strength (Mpa)

Calculations

Formula = $\frac{2P}{\pi dl}$

Where

P= Breaking load, d= dia of the specimen, l= length of the specimen

SPLIT TENSILE STRENGTH OF CONCRETE

AIM: To determine the split tensile strength of concrete of given mix proportions.

APPARAT: Compression testing machine weighing machine mixer, tamping rods

THEORY: The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure.

PROCEDURE:

1. Take mix proportion as 1:2:4 with water cement ratio of 0.6. Take 21kg of coarse aggregate, 10.5 kg of fine aggregate 5.25kg of cement and 3.l5 liters of water. Mix them thoroughly until uniform colour is obtained. This material will be sufficient for casting three cylinders of the size 150mm diameter X 300 mm length. In mixing by hand cement and fine aggregate be first mixed dry to uniform colour and then coarse aggregate is added and mixed until coarse aggregate is uniformly distributed throughout the batch. Now the water shall be added and the ingredients are mixed until resulting concrete is uniform in colour. Mix at least for two minutes.
2. Pour concrete in moulds oiled with medium viscosity oil. Fill the cylinder mould in four layers each of approximately 75 mm and ram each layer more than 35 times with evenly distributed strokes.
3. Remove the surplus concrete from the tope of the moulds with the help of the trowel.
4. Cover the moulds with wet mats and put the identification mark after about 3 to 4 hours.
5. Remove the specimens from the mould after 24 hours and immerse them in water for the final curing. The test is usually conducted at the age of 7-28 days. The time age shall be calculated from the time of addition of water to the dry ingredients.
6. Test at least three specimens for each age of test as follows
   I. Draw diametrical lines on two ends of the specimen so that they are in the same axial plane.
   II. Determine the diameter of specimen to the nearest 0.2 mm by averaging the diameters of the specimen lying in the plane of premarked lines measured near the ends and the middle of the specimen. The length of specimen also shall be taken be nearest 0.2 mm by averaging the two lengths measured in the plane containing pre marked lines.

III. Centre one of the plywood strips along the centre of the lower platen. Place the specimen on the plywood strip and align it so that the lines marked on the end of the specimen are vertical and centered over the plywood strip. The second plywood strip is placed length wise on the cylinder center on the lines marked on the ends of the cylinder.

IV. The assembly is positioned to ensure that lines marked on the end of specimen are vertical and the projection of the plane passing through these two lines interest the centre of the platen.

7. Apply the load without shock and increase it continuously at the rate toproduce a split tensile stress of approximately1.4 to 2.1 N/mm^2/min, until nogreater load can be sustained. Record the maximum load applied to specimen
8. Note the appearance of concrete and any unusual feature in the type of failure.
9. Compute the split tensile strength of the specimen to the nearest 0.25 N/mm^2

PRECAUTIONS

a. The mould and base plate must be oiled lightly before use
b. The specimen should be made and cured as per IS 516-1959
c. The specimen should be tested immediately on removal from the water
d. The specimen should be placed in testing machine centrally
e. Load should be applied without shock

RESULT

FLEXURAL STRENGTH OF CONCRETE BEAM

Aim: To find the flexural strength of concrete beam specimen.

Apparatus: Flexure testing machine, beam moulds and accessories.

Theory: The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate7kg/sq cm/min. The permissible errors shall be not greater than ± 0.5percent of the applied load where a high degree of accuracy is required and not greater than ± 1.5 percent of the applied load for commercial type of use. The bed of the testing machine shall be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers shall be so mounted that the distance from centre to centre is 60 cm for 15.0 cm specimens or 40 cm for 10.0 cm specimens. The load shall be applied through two similar rollers mounted at the third points of the supporting span, that is, spaced at 20 or 13.3 cm centre to centre. The load shall be divided equally between the two loading rollers, and all rollers shall be mounted in such a manner that the load is applied axially and without subjecting the specimen to any torsional stresses or restraints.

Procedure:

1) The test specimens stored in water for 48 hrs before testing shall be taken and tested immediately in the wet condition only.
2) The dimension of each specimen shall be noted before testing.
3) Any loose sand and other materials are wiped clean from the surface.
4) The specimen shall be kept on the machine such that the centre line of the specimen and the axis is aligned properly. Load is applied at a rate of 7kg/sqcm/min ie at 400kg/min for 15cm specimen.
5) The load is applied till the specimen fails and the max load is noted down.

Calculation:

Modulus of Rupture $f_b = pl/bd^2$

if a is greater than 20cm for 15cm specimen and 13.3cm for 10cm specimen.

$f_b = 3pa/bd^2$

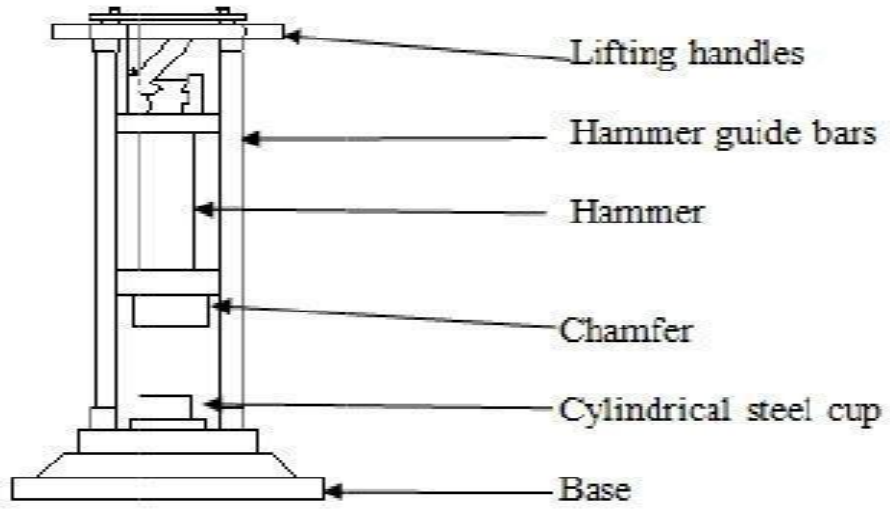
If a is less than 20cm but greater than 17cm for 15cm specimen and
If a is less than 13.3cm and greater than 11cm for 10cm specimen.
If a is less than 17cm and 11 cm for 15 and 10 cm specimen respectively, the results shall be discarded

b=width of specimen, l=span (distance between supports)
d=depth of specimen p= Max load.

Result:

1. Size of specimen_____
2. Max Load _____
3. Position of fracture (a) _____
4. Modulus of rupture_____(kg/cm^2)

1. What is the bending equation?
2. What is the bending stress for „T“ section?
3. What is the significance of moment of inertia with respect to bending stress?
4. How does the centroid affects the bending stress for different shapes of beams?



AGGREEGATE IMPPACT TESTING MACCHINE

OBSERVATION

	Sample I	Sample II
Total weight of dry sample taken= W_1 gm		
Weight of portion passing 2.36 mm sieve= W_2gm		
Aggregate impact = (W_2/W_1)*100 Value (per cent)		

AGGREGATE IMPACT TEST

AIM: To determine the impact value of the road aggregates

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

a) ***Impact testing machine:*** The machine consists of a metal base with a plane lower surface supported well on a firm floor, without rocking. A detachable cylindrical steel cup of internal diameter 10.2 cm and depth 5 cm is rigidly fastened centrally to the base plate. A metal hammer of weight between 13.5 and 14.0 kg having the lower end cylindrical in shape 10 cm in diameter and 5 cm long, with 2 mm chamber at the lower edge is capable of sliding freely between vertical guides, and fall concentric over the cup. There is an arrangement for raising the hammer and allowing it to fall freely between vertical guides from a height of 38 cm on the test sample in the cup, the height of fall being adjustable upto 0.5 cm. A key is provided for supporting the hammer while fastening or removing the cup.

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

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

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

(e) Balance: A balance of capacity Dot less than 500 g to weigh accurate upto 0.1 g.

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

PROCEDURE:

The test sample: It consists of aggregates sized 12.5 mm - 10.0 mm. The aggregate should be dried by heating at 1000^0-110^0C for a period of 4 hours and cooled.

1. Sieve the material through 12.5 mm and 10.0 mm IS sieve the aggregates passing through 12.5 mm sieve and retained on 10.0 mm sieve comprises the test material.
2. Pour the aggregates to fill about 1/3rdd depth of measuring cylinder.
3. Compact the material by giving 25 gentle blows with the rounded end of the tamping rod.
4. Add two more layers in similar manner, so that cylinder is full.
5. Strike off the surplus aggregates.

6. Determine the net weight of the aggregates to the nearest gram (W_1).
7. Bring the impact machine to rest without wedging or packing up on the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.
8. Fix the cup firmly in position on the base of machine and place whole of the test sample in it and compact by giving 25 gentle strokes with tamping rod.
9. Raise the hammer until its lower face is 380 mm above the surface of the aggregate sample in the cup and allow it to fall freely on the aggregate sample. Give 15 such blows at an interval of not less than one second between successive falls.
10. Remove the crushed aggregate from the cup and sieve it through 2.36 mm IS sieves until no further significant amount passes in one minute. Weigh the fraction passing the sieve to an accuracy of 1 gm (W_2). Also weigh the fraction retained in the sieve.
11. Note down the observations in the Performa and compute the aggregate impact value. The mean of two observations, rounded to nearest whole number is reported as the Aggregate Impact Value.

PRECAUTIONS:

1. Place the plunger centrally so that it falls directly on the aggregate sample and does not touch the walls of the cylinder in order to ensure that the entire load is transmitted on to the aggregates.
2. In the operation of sieving the aggregates through 2.36 mm sieve the sum of weights of fractions retained and passing the sieve should not differ from the original weight of the specimen by more than 1 gm.
3. The tamping is to be done properly by gently dropping the tamping rod and not by hammering action. Also the tampering should be uniform over the surface of the aggregate taking care that the tamping rod does not frequently strike against the walls of the mould.

REPORTING OF RESULTS

The mean of the two results shall be reported to the nearest whole number as the aggregate impact value of the tested material.

Aggregate impact value is used to classify the stones in respect of their toughness property as indicated below in Table 1.

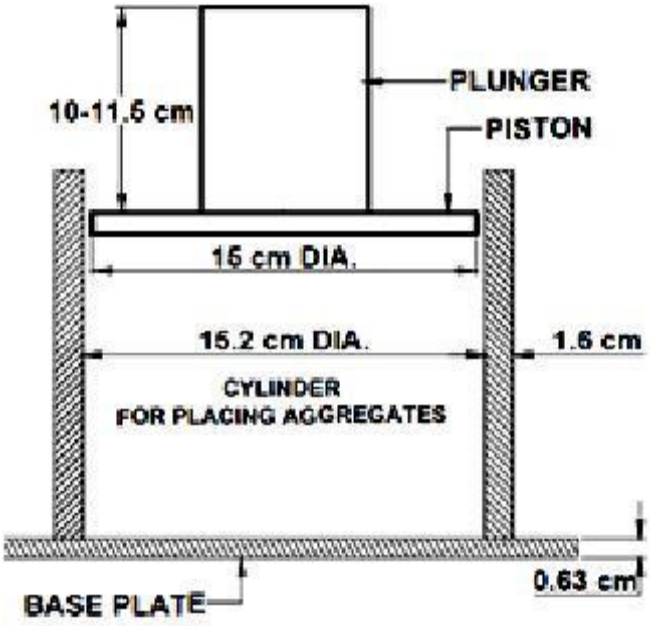
Table 1: Classification of aggregate based on aggregate impact value

Aggregate impact value (%)	Quality of aggregate
< 10	Exceptionally strong
10 – 20	Strong
20 – 30	Satisfactory for road surfacing
>35	Weak for road surfacing

Table 2: Maximum allowable impact values of aggregate in different types of Pavement material/ layers

Sl.No	Types of pavement material /layer	Aggregate impact value (%)
1	Water bound macadam, sub-base course	50
2	Cement concrete, base course	45
3	i) WBM base coarse 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 surface dressing v) Bituminous macadam, binder course vi) Bituminous carpet vii) Bituminous/Asphaltic concrete viii) Cement concrete, surface course	30

RESULT =



Aggregate Crushing Test Apparatus

OBSERVATION

	Sample I	Sample II
Total weight of dry sample taken= W_1 gm		
Weight of portion passing 2.36 mm sieve= W_2gm		
Aggregate crushing = $(W_2/W_1)*100$ Value (per cent)		

AGGREGATE CRUSHING VALUE TEST

AIM: To determine the aggregate crushing value of coarse aggregates.

APPARATUS: The apparatus of the aggregate crushing value test as per IS: 2386 (Part IV) – 1963consists of:

1. A 15cm diameter open ended steel cylinder with plunger and base plate, of the general form and dimensions as shown in Fig
2. A straight metal tamping rod of circular cross-section 16mm diameter and 45 to 60 cm long, rounded at one end.
3. A balance of capacity 3k, readable and accurate up to 1 g.
4. IS Sieves of sizes 12.5,10 and 2.36 mm
5. A compression testing machine capable of applying load up to 40tonnes. At uniform rate of 4tonnes. /minute
6. Cylindrical measure having internal dia. of 11.5cm. & height 18 cm. For measuring the sample.

THEORY: The aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. Crushing value is a measure of the strength of the aggregate. The aggregates should therefore have minimum crushing value.

PROCEDURE: The test sample: It consists of aggregates sized 12.5 mm - 10.0 mm(minimum 3kg). The aggregates should be dried by heating at 100^0-110^0 C for a period of 4 hours and cooled.

1. Sieve the material through 12.5 mm and 10.0 mm IS sieve. The aggregates passing through 12.5 mm sieve and retained on 10.0 mm sieve comprises the test material.
2. The cylinder of the test shall be put in position on the base-plate and the test sample added in thirds, each third being subjected to 25 strokes with the tamping rod.
3. The surface of the aggregate shall be carefully leveled
4. The plunger is inserted so that it rests horizontally on this surface, care being taken to ensure that the plunger does not jam in the cylinder
5. The apparatus, with the test sample and plunger in position, shall then be placed between the plates of the testing machine.
6. The load is applied at a uniform rate as possible so that the total load is reached in 10 minutes. The total load shall be 40 tones.
7. The load shall be released and the whole of the material is removed from the cylinder and sieved on 2.36mm IS Sieve.
8. The fraction passing the sieve shall be weighed and recorded.

PRECAUTIONS

1. The plunger should be placed centrally & rest directly on the aggregates .Care should be taken that it does not touch the walls of the cylinder so as to ensure that the entire load ids transferred onto the aggregates.

2. In the operation of sieving the aggregates through 2.36mm sieve & weighing care should be taken to avoid loss of fines. The sum of weights of fractions retained & passing the sieve should not differ from the originals weights of the specimen by more than 1gm.
3. The tamping should be done properly by gently dropping the tamping rod and not by hammering action Also the tamping should be uniform over the surface.

REPORTING OF RESULTS

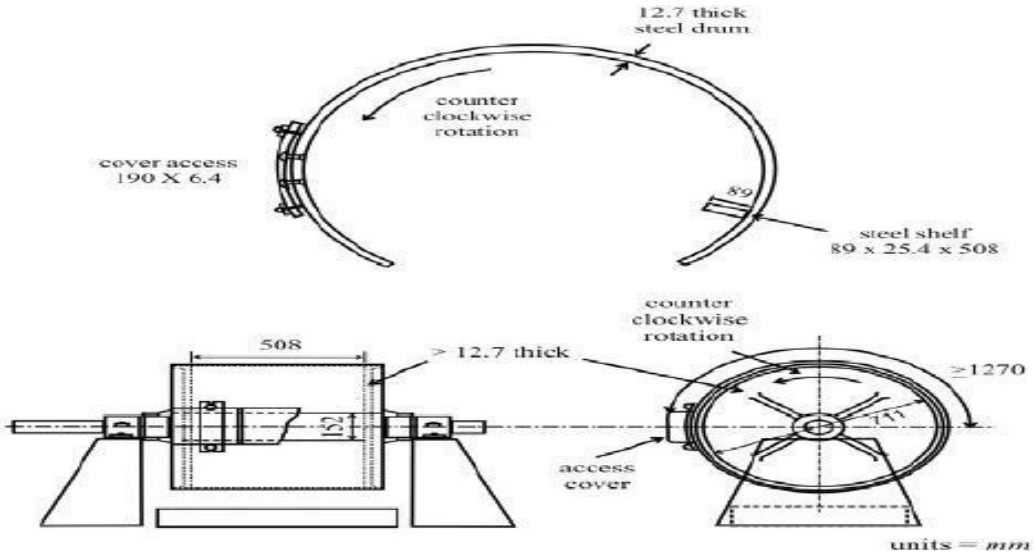
The mean of the two results shall be reported to the nearest whole number as the 'aggregate crushing value' of the size of the material tested.

RESULT

Mean aggregate Crushing test value =

STANDARD RESULTS: The suitability of aggregate is adjudged, dependent upon its proposed used in the pavement layers. The table below shows the specified limits of present aggregate crushing value, for different types of road construction.

Sl.no.	Type of Road construction	Aggregate crushing value not more than
1.	Flexible Pavements a) Soiling b) Water –Bound- Macadam c) Bituminous macadam d) Bituminous surface- dressing or thin premix carpet Dense- mix carpet	 50 40 40 30
2.	Rigid Pavements a) Other than wearing course b) Surface wearing course	 45 30



LOS ANGELES ABRASION TESTING MACHINE

OBSERVATIONS

	Sample I	Sample II
Total weight of dry sample taken= W_1 gm		
Weight of portion passing 1.7 mm sieve= W_2gm		
Aggregate abrasion value = (W_2/W_1)*100 Value (per cent)		

ABRASION TEST

AIM: To determine Los Angeles abrasion valueof coarse aggregates.

APPARATUS: The apparatus as per IS: 2386 (Part IV) – 1963 consists of:

a) Los Angeles Machine: It consists of a hollow steel cylinder, closed at both the ends with an internal diameter of 700 mm and length 500 mm and capable of rotating about its horizontal axis. A removable steel shaft projecting radially 88 mm into cylinder and extending full length (i.e. 500 mm) is mounted firmly on the interior of cylinder. The shelf is placed at a distance 1250 mm minimum from the opening in the direction of rotation.

b) Abrasive charge: Cast iron or steel balls, approximately 48 mm in diameter and each weighing between 390 to 445 g; 6 to 12 balls are required.

c) Sieve: The 1.70 mm IS sieve

d) Balance of capacity 5 kg or 10 kg

e) Drying oven

f) Miscellaneous like tray etc

THEORY: The abrasion value of the aggregates is determined in order to determine their resistance against wearing. In this the aggregate sample is mixed with abrasive charge consisting of six standard balls & rotated in closed inclined cylinders for specific number of revolutions. The abrasion value is then expressed as the percentage of abraded material with reference to the original weight of the test sample.

PROCEDURE: Test Sample: It consists of clean aggregates dried in oven at 105^0- 110^0C and are coarser than 1.70 mm sieve size. The sample should conform to any of the grading shown in table.

TABLE 1 GRADING OF TEST SAMPLE

Sieve size (square hole)		Weight in g of Test Sample for Grade						
Passing mm	Retained on mm	A	B	C	D	E	F	G
80	63	-	-	-	-	2500*	-	-
63	50	-	-	-	-	2500*	-	-
50	40	-	-	-	-	5000*	5000*	-
40	25	1250	-	-	-	-	5000*	5000*
25	20	1250	-	-	-	-	-	5000*
20	12.5	1250	2500	-	-	-	-	-
12.5	10	1250	2500	-	-	-	-	-
10	6.3	-	-	2500	-	-	-	-
6.3	4.75	-	-	2500	-	-	-	-
4.75	2.36	-	-		5000	-	-	-

*Tolerance of ±12 percent permitted.

1. Select the grading to be used in the test. It should be chosen such that it conforms to the grading to be used in construction, to the maximum extent possible.
2. Take 5 kg of sample for grading A, B, C or D and 10 kg for grading E, F and G.
3. Choose the abrasive charge as per Table 2.

TABLE 2 SELECTION OF ABRASIVE CHARGES

Grading	No. of Steel balls	Weight of charge, g
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 25
D	6	2500 ± 25
E	12	5000 ± 25
F	12	5000 ± 25

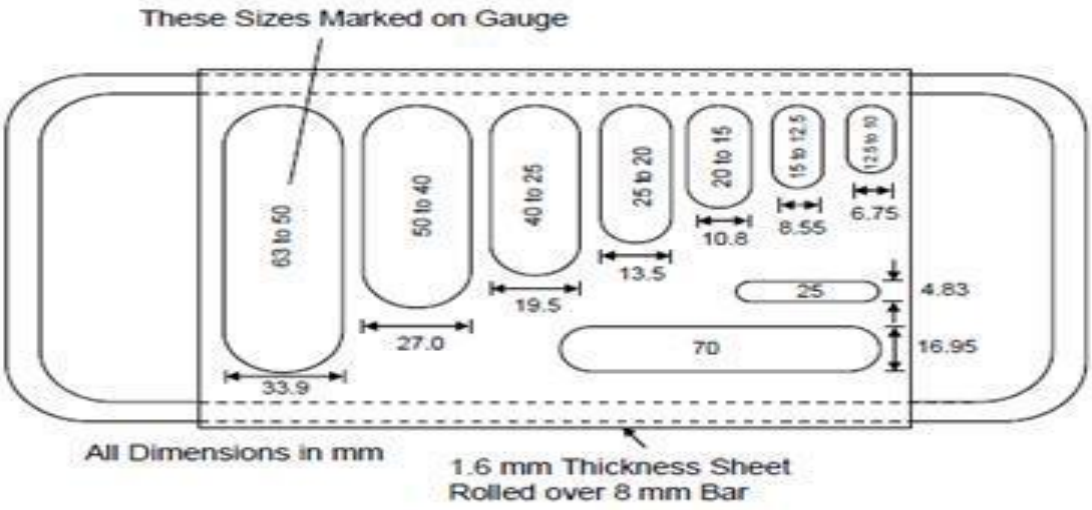
1. The test sample and the abrasive charge shall be placed in the Los Angles abrasion testing machine.
2. The machine is rotated at a speed of 20 to 33 rev/min for grading A, B,C and D, the machine shall be rotated for 500 revolutions; for grading E, F and G, it shall be rotated for 1000 revolutions
3. The material is discharged from the machine after the completion of the test and is sieved through 1.7 mm IS sieve.
4. The weight of the aggregate passing through 1.7mm sieve is taken and recorde

REPORTING OF RESULTS The difference between the original weight and the final weight of the test sample shall beexpressed as a percentage of the original weight of the test sample. This value is reported asthe percentage wear.

TABLE 3. MAXIMUM L A ABRASION VALUES OF AGGREGATES IN DIFFERENT TYPES OF PAVEMENT LAYERS

Sl no.	Types of pavement layer	Maximum Los Angeles Abrasion value (%)
1	Water bound macadam ,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	35
5	i) Bituminous concrete surface course ii) Cement concrete pavement surface course	30

RESULT: Mean Los Angeles Abrasion value =



Thickness Gauge

CALUCULATIONS

Flakiness index= $100 * \frac{w}{W}\%$

Where,***w*** is the weights of material passing the various thickness gauges and **W** is the total weights of aggregate passing and retained on the specified sieves.

SHAPE TEST

A. FLAKINESS INDEX

AIM: This method of test lays down the procedure for determining the flakiness index of the coarse aggregate.

APPARATUS The apparatus shall consist of the following:

1) A balance – The balance shall be of sufficient capacity and sensitivity and shall have an accuracy of 0.1 percent of the weight of the test sample

2) Metal Gauge – The metal gauge shall be of the pattern as shown in Fig

3) Sieves – The sieves of sizes as shown in Table

PRINCIPLE The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimension (thickness) is less than three-fifths of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

PROCEDURE

1. A quantity of aggregate shall be taken sufficient to provide the minimum number of200 pieces of any fraction to be tested.
2. The sample shall be sieved with sieves specified in Table
3. Then each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in Fig 4 or in bulk on sieves having elongated slots. The width of the slot used in the gauge or sieve shall be of the dimensions specified in column 3 of Table for the appropriate size of material.
4. The total amount of aggregate passing the gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample.

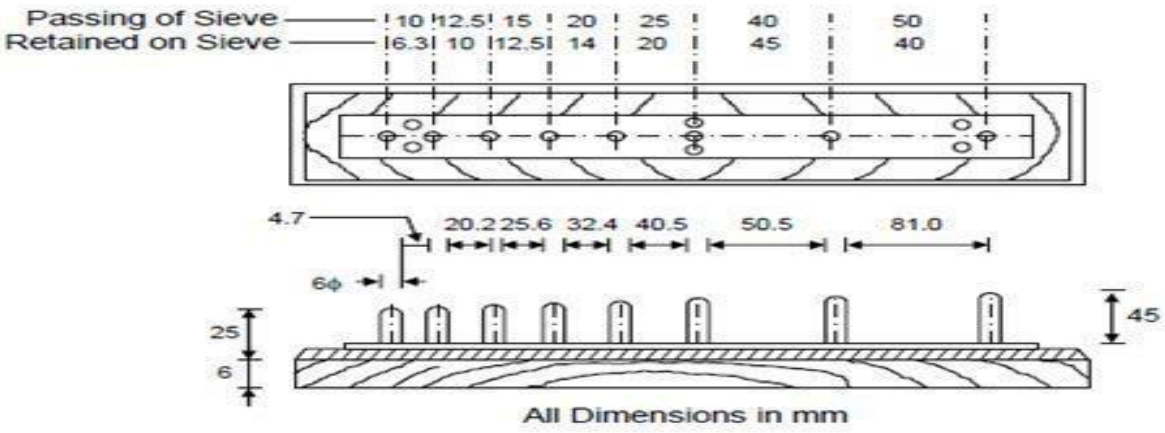
Dimensions of Thickness and Length gauge

SIZE OF AGGREGATE (mm)		THICKNESS	LENGTH
Passing through IS sieve	Retained on IS sieve	THICKNESS GAUGE(mm)	LENGTH GAUGE(mm)
63	50	33 .90	-
50	40	27.00	81.0
40	31.5	19 .50	58.5
31.5	25	16.95	-
25	20	13 .50	40.5
20	16	10.80	32.4
16	12.5	8. 55	25.6
12.5	10	6.75	20.2
10	6.3	4. 89	14.7

*This dimension is equal to 0.6 times the mean sieve size.

This dimension is equal to 1.8 times the mean sieve size.

RESULT=



Length Gauge

CALUCULATIONS

Elongation index= $100 * \frac{x}{W}\%$

Where,***x***is the weight of materials retained on specified gauges and **W** is the total weights of aggregate passing and retained on the specified sieves.

B. ELONGATION INDEX

AIM: This method of test lays down the procedure for determining the elongation index of the coarse aggregate.

APPARATUS

a) The apparatus shall consist of the following:

b) A balance – The balance shall be of sufficient capacity and sensitivity and shall have an accuracy of 0.1 percent of the weight of the test sample

c) Metal Gauge – The metal gauge shall be of the pattern as shown in Fig

d) Sieves – The sieves of sizes as shown in Table

THEORY The elongation index of an aggregate is the percentage by weight of particles in it whose greatest dimension (thickness) is greater than one and four-fifths of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

PROCEDURE

1. A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested.
2. The sample shall be sieved with sieves specified in Table
3. Each fraction shall be gauged in turn for length on a metal gauge of the pattern shown in Fig. The gauge length used shall be of the dimensions specified in column 4 of Table for the appropriate size of material.
4. The total amount of aggregate retained by the length gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample

RESULT

SPECIFIC GRAVITY OF AGGREGATES

AIM: To determine the specific gravity of aggregates.

THEORY: The specific gravity of coarse aggregate is defined as the ratio between the mass of equal volumes of coarse aggregate & water at the same constant temperature. For design of concrete mix, information should be available about specific gravity of the aggregates. Specific gravity of an aggregate gives valuable information on its quality & properties. If the specific gravity is above or below the assigned to a particular type of aggregate, it may indicate that shape & grading of aggregate has altered.

APPARATUS: Balance of capacity of 5 kg, weight box, wire basket, absorbent cloth for surface drying of the sample, 4.75mm IS sieve.

PROCEDURE:

- Take about 5 kg of coarse aggregate by method of quartering rejecting all material passing 4.75mm sieve.
- Wash thoroughly to remove dust, etc., from the surface of particles. Dry to constant mass at a temperature of 105 ± 5 deg C.
- Immerse the sample in water at 22 to 32 deg C for a period of (24 ± ½) hours (30 minutes in practice).
- Remove the aggregate from water & roll the same in a large piece of an absorbent cloth until all visible films are remove, although the surface of particles will still appear to be damp.
- Now, weigh 3 kg of this sample in the saturated surface dry condition & note down the mass as W_1 gm.
- Place the weighed aggregate immediately in the wire basket & dip it in water. Weigh this basket with aggregate, while keeping it in water, with the help of the balance. Note its mass as W_3 gm.
- Note down the weight of the suspended wire basket in water without aggregate as W_2 gm.
- Dry the sample to the constant weight at the temperature of 100 to 110 deg. C for (24 ± ½) hours.
- Cool to room temperature & weigh it & note down the mass as W_4 gm.
- Calculate the specific gravity.

OBSERVATION:

	Trial 1	**Trail 2**	**Trail 3**
Mass of saturated surface dry sample W_1 gm			
Mass of basker suspended in water W_2 gm			
Mass of material + basket suspended in water W_3 gm			
Mass of oven dry aggregate in air W_4 gm			

RESULT:

CONCLUSION:

WATER ABSORPTION OF AGGREGATE

AIM: To determine the percentage of water absorption of aggregates.

THEORY: Some of the aggregate are porous & absorptive. Porosity & absorption of aggregates will affect the w/c ratio & hence the workability of concrete.
APPARATUS: Aggregate, 4.75mm IS sieve, and water bath.
PROCEDURE:

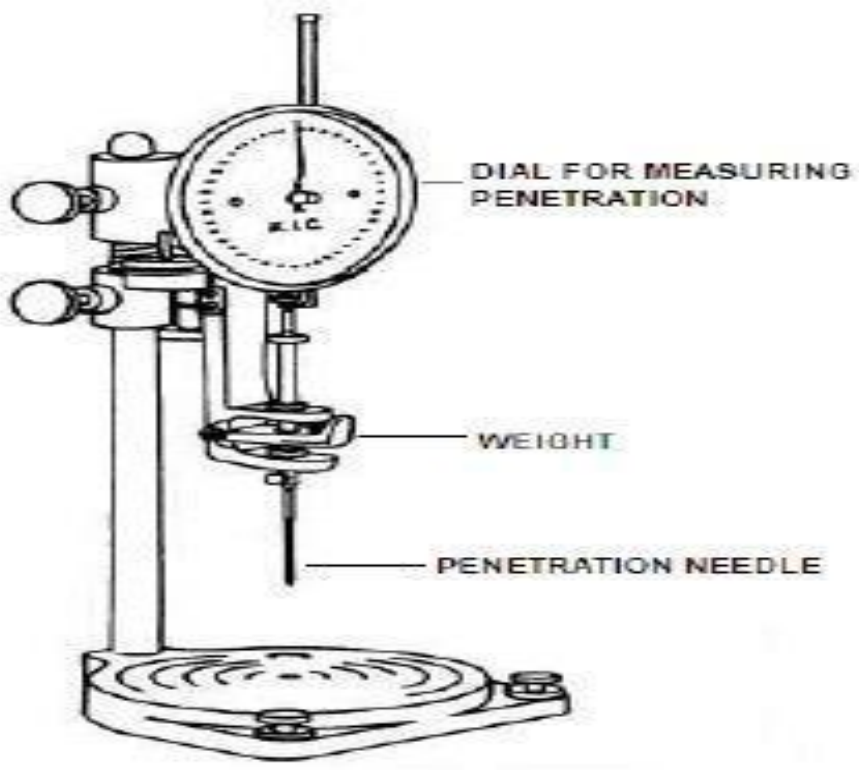
- Take 5 Kg of coarse aggregates passing through IS 10 mm sieve & retained in 4.75mm IS sieve..
- Remove the dirt, etc., and immerse the aggregate in a water bath for 24 hours at 22 to 32 deg C.
- After that, remove the aggregates from the water bath and roll the same in a large piece of an absorbent cloth until all visible films are removed.
- Now weigh about 3 kg. of this sample in the saturated surface dry condition & note down the mass as W1 gm.
- Dry the sample to constant weight at the temperature of 100 to 110 deg C for 24 hours. Note down the reading as W2 gms.

OBSERVATION:

Wt. of saturated dry aggregate	W1	
Weight of oven dry aggregate	W2	
Water Absoption	[(W2-W1)/W2] X 100	

RESULT:

CONCLUSION:



Penetrometer

OBSERVATIONS & CALCULATIONS:

SL. No.	Particulars	Test 1	Test 2	Test 3
1.	Penetrometer Dial reading a) Initial			
	b) Final			
2.	Penetration Value			
	Mean Penetration Value =			

PENETRATION TEST

AIM: To determine the consistency of bituminous material

APPARATUS:

a) **Container A** flat bottomed cylindrical metallic dish 55 mm in diameter and 35 mm in depth is required. If the penetration is of the order of 225 or more deeper dish of 70 mm diameter and 45 mm depth is required.

b) **Needle**: A straight, highly polished, cylindrical hard steel rod, as per standard dimensions

c) **Water bath**-A water bath maintained at 25 ± 0.1^0Ccontaining about 10ltrs. Of water. The sample being immersed to a depth not less of than 100mm from the top & supported on a performed shell not less than from the bottom of the bath.

d) **Transfer dish or tray**: It should provide support to the container and should not rockthe container. It should be of such capacity as to completely immerse the containerduring the test.

e) **Penetration apparatus**: It should be such that it will allow the needle to penetrate without much friction and is accurately calibrated to give results in one tenth of a millimeter

f) **Thermometer**: Range 0- 440 C and readable up to 0.20C

g) **Time measuring device**: With an accuracy ± 0.1 sec

THEORY

Penetration value is a measurement of hardness or consistency of bituminous material. It is the vertical distance traversed or penetrated by the point of a standard needle in to the bituminous material under specific conditions of load, time, and temperature. This distance is measured in one tenth of a millimeter. This test is used for evaluating consistency of bitumen. It is not regarded as suitable for use in connection with the testing of road tar because of the high surface tension exhibited by these materials and the fact that they contain relatively large amount of free carbon.

PROCEDURE:

1. Preparation of test specimen- Soften the material to a pouring consistency at a temperature not more than 60^0C for tars and 90^0C for bitumen's above the approximate softening point and stir it thoroughly until it is homogeneous and is free from air bubbles and water. Pour the melt into the container to a depth at least 10mm in excess of the excepted penetration. Protect the sample from dust and allow it to cool in an atmosphere

at a temp. Between 15^0C to 30^0C for an hour. Then place it along with the transfer dish in the water bath at 25^0C $\pm 0.1^0$C & aloe it remain for one to one and half hour. The test is carried out at 25^0C $\pm 0.1^0$C unless otherwise stated.

2. Fill the transfer dish water from the water bath to depth sufficient to cover the container completely. Place the sample in it and put it upon the sand of the penetration apparatus.

3. Clean the needle with benzene, dry it load with the weight, the total moving load required is 100±0.25gms. Including the weight of the needle, carrier, and superimposed weights.

4. Adjust the needle with to make contact with surface if the sample. This may be done by placing the needle point in contact with its image reflected by the surface of the bituminous material.

5. Make the pointer of the dial to read zero or note the initial dial reading.

6. Release the needle for exactly 5 sec.

7. Adjust the penetration machine to measure the distance penetrated.

8. Make at least 3 readings at points on the surface of the sample not less than 10mm apart and not less than 10mm from the side of the dish, after each test return the sample and transfer dish to the water bath & wash the needle. Clean with benzene& dry it in case of material of penetration greater then 225,3 determinations on each of the 2 identical test specimens using a separate needle for each determine should be made, leaving the needle in the sample on completion of each determinations to avoid disturbance of the specimen.

RESULT

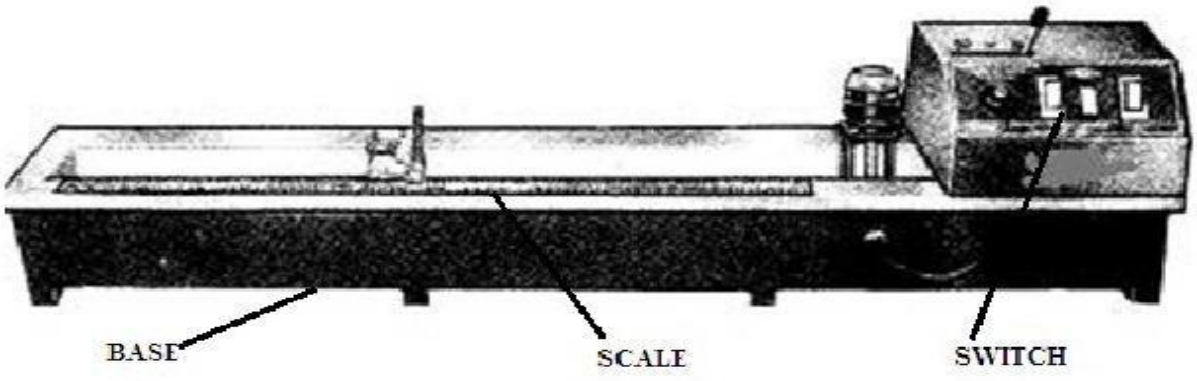
STANDARDS

The Indian 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	A25	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



Briquette Mould



Ductility Testing Machine

OBSERVATIONS AND CALCULATION:

Sl.no	Particulars	Briquette mould no.		
		1	2	3
1	Initial reading = a =			
2	Final reading = b =			
3	Ductility in cms = b =			

DUCTILITY TEST

AIM: To measure the ductility of a given sample of bitumen.

APPARATUS

a) Briquette mould: It is made up of brass with the shape as shown in fig. The ends b &b are known as clips and the parts a & a as sides of the mould, the dimensions of the mould shall be such that when properly assembled it will form a briquette specimen having the following dimensions.

a. Total length 75.0±0.5mm
b. Distance between clips 30.0±0.3mm
c. Width at mouth of clip 20.0±0.2mm
d. Width at min. cross section
e. (Half way between clips) 10.0±0.1mm
f. Thickness through h out 10.0±0.1mm

b) **Water bath:** The water bath must have a thermostat maintained with in $\pm 0.1^0$C of the specified test temperature it should contain 10ltrs. Of water. The specimen is to be immersed up to a depth of not less than 100mm being supported on a perforated shelf of about 50mm from the bottom of the bath.

c) Testing machine: For pulling a briquette of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously immersed in water while the two clips of pulled apart horizontally at a uniform specific a speed. It also must have suitable arrangements for stirring water to attain uniform temperature.

THEORY

The ductility test gives a measure of adhesive property of bitumen and its ability to stretch. In a flexible pavement design, it is necessary that binder should form a thin ductile film around the aggregates so that the physical interlocking of the aggregates is improved. Binder material having insufficient ductility gets cracked when subjected to repeat traffic loads and it provides pervious pavement surface. Ductility of a bituminous material is measured by the distance in centimeters to which it will elongate before braking when two ends of standard briquette

specimen of the material are pulled apart at a specified speed and at a specified temperature.

PROCEDURE

Preparation of test specimen: The test specimen is prepared by melting the bituminous material by a temperature 75^0C to 100^0C approximate. Above the softening point until it becomes thoroughly fluid. The mould is assembled on a brass plate & its interiors as well as brass plate should be coated with on equal mixture of glycerine&dextine to prevent sticking the fluid materials is then poured in a thin stream, back& forth from end to end mould until it is more than full. It is closed to room temp. For 30-40min. and then placed in the water bath for 30mins. After which the excess is cutoff by means of hot spatula so that the mould shall be just full & level.

a) Remove the side pieces and brass plate

b) Keep the briquette mould in the testing machine and hook the clips carefully with out causing any initial strain.

c) Adjust the pointer to read zero or initial reading of the pointer to be noted.

d) Start the machine & pull two clips horizontally at a speed of50mm/min.

e) Note the distance at which the bitumen thread of specimen breaks.

PRECAUTIONS:

1. The plate assembly upon which the mould is placed shall be perfectly flat & level so that the bottom surface of the mould touches it throughout.
2. In filling the mould, care should be taken not to disarrange the parts & thus distort the briquette & to see that no air pockets shall be with in the molded sample.
3. If the bituminous material comes in contact with water surface or rests on the bottom of the water bath the test should not be considered as normal. In that case, the specific gravity of water is adjusted by adding either methyl alcohol or sodium chloride so that the bituminous material doesn't comes to the surface or touch the bottom at any time during the test.

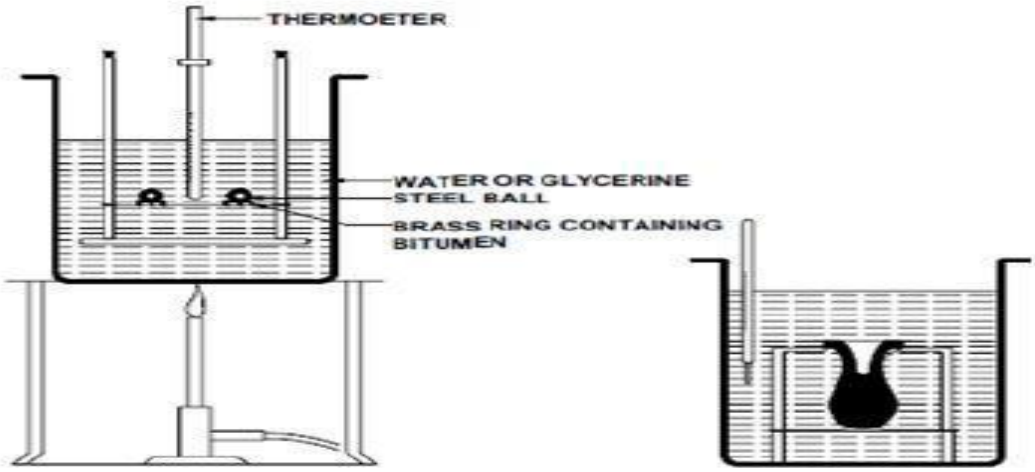
RESULT

STANDARD RESULTS:

The suitability of bitumen is judged, depending upon its type and proposed use. Bitumen with low ductility value may get cracked especially in cold water. ISI has specified following values of min. ductility for various grades of bitumen as follows.

Source of paving bitumen and penetration grade	Minimum ductility value in cms.
Assam petroleum A 25	5
A 35	10
A 45	12
A65, A90 & A200	15
Bitumen from sources other than Assam petroleum	
S35	50
S45,S65,S90	75

COMMENTS



Assembly of Apparatus For Determination of Softening Point (Ring & Ball)

OBSERVATION & CALCULATIONS:

Liquid Used In the Bath

Temperature when the ^{0}	Ball 1	Ball 2
Average		

SOFTENING POINT TEST

AIM: To determine the softening point of given bituminous material

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: The softening point of bitumen or tar is the temperature at which the substance attains a particular degree of softening. As per IS:334-1982, it is the temperature (in o C) at which a standard ball passes through a sample of bitumen in a mould and falls through a height of 2.5 cm, when heated under water or glycerin at specified conditions of test. The binder should have sufficient fluidity before its applications in road uses. The determination of softening point helps to know the temperature up to which a bituminous binder should be heated for various road use applications. Softening point is determined by ring and ball apparatus.

PROCEDURE

Preparation of test sample: Heat the material to a temperature between 75^0c to 100^0c above its softening point. Stir until it is completely fluid & free from air bubbles and water if necessary filter it throws IS sieve 30. Place the rings, previously heated to a temperature approximating to that of the molten material, on a metal plate which has been smeared with a mixture in air, level the material in the ring by removing the excess with a warmed sharp knife.

1. Assemble the apparatus with rings, thermometer& ball guides in position.
2. Fill the bath distilled water to a height of 50mm above the upper surface o the rings.
3. Apply each to the bath & stir the liquid so the temperature rises at a uniform rate of a. 5+0. 5^0c/minute.
4. As the temperature increases the bituminous material softness & the balls sinks through the ring, carrying a portion of the material with it.
5. Note down the temperature when any of the steel with bituminous coating touches the bottom plate.

6. Record the temperature when the second ball also touches the bottom plate.
7. The average of the two readings to the nearest 0.5^0c is reported as the softening point.

Note: Use Glycerin in place of water if the softening point is excepted to be above 80^0c & the starting temperature of the test is 35^0c

PRECAUTIONS:

1. Distilled water should be used as the heating medium.
2. During the conduct of test the apparatus should not be subjected to vibrations.
3. The bulb of the thermometer should be at about the same level as the rings.

STANDARD RESULTS: Softening point indicates the temperature at which binders possess the viscosity. Bituminous materials do not have a definite melting point; rather the change of state form solid to liquid is gradually & over a wide range of temperature. Softening point as particular significance for materials that are to be used as joint & crack fillers. Higher softening point ensures that they will not flow during service. In general, the higher the softening point the lesser the susceptibility. Bitumen with higher softening point may be prepared in warmer places. The result obtained shall not differ from the mean by more than the following.

Softening point(^{0}c)	Repeatability (^{0}c)	Reproducibility(^{0}c)
40-60	1.0	5.5
61-80	1.5	5.5
81-100	2.0	5.5
101-120	2.5	5.5
121-140	3.0	5.5

RESULT

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

Bitumen Grades	Softening point, °C
*A25&A35	55 to 70
*S35	50 to 65
A45,S45&A65	45 to 60
S65	40 to 55
A90&590	35 to 50
A 200 & S 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.

COMMENTS

FLASH & FIRE POINT TEST FOR BITUMINOUS SAMPLE

AIM: To determine the flash and fire point for the given bituminous sample

APPARATUS:

a. Open Cup Tester is same as standard Pensky-Marten tester with the modification that cover of the cup is replaced by a clip which encircles the upper rim of the cup and carries a test flame
b. Thermometer
c. A stove / heating device with provision to adjust the rate of heating

THEORY: The flash point of a material is the lowest temperature at which the application of test flame causes the vapors from the material momentarily catch fire in the form of a flash under specified conditions of test.

The fire point is the lowest temperature at which the application of test flame causes the material to ignite and burn at least for 5s under specified conditions of test.

PROCEDURE

1. All the parts of the open cup tester and the accessories are cleaned and dried.
2. The cup is filled with the sample of bituminous binder up to the level of the filling mark.
3. The clip supporting the thermometer and test flame is placed in position on the cup.
4. The thermometer is inserted and the open cup tester is set on the stove.
5. The test flame is lighted and adjusted to size 4 mm bead and it is fixed in the vertical axis of the cup, level with the upper edge of the cup.
6. The bitumen sample in the tester is heated and the rate of heating is adjusted such that the temperature of the test specimen increases at the rate of 5°C to 6°C per minute.
7. A burning match stick is placed at the binder surface from time to time and the appearance of flash, if any, is observed.
8. When the flash occurs the first time, the temperature at that instance is recorded as the flash point.

REPORTING OF RESULTS

The temperature of the binder when flash first appears at any point on the surface of the material is noted and recorded as the flash point under open cup flash point test.

The heating is continued at the same rate until the binder itself gets ignited and continues to burn for five seconds. When it occurs, the temperature of the material is noted and is recorded as the fire point.

RESULT

1. **Flash point of the given bituminous material ……..**
2. **Fire point the given bituminous material ……..**

OBSERVATIONS & CALCULATIONS:

Sl.no.	Particulars	Test 1	Test2
1.	Test temperature		
2.	Time taken to follow50cc of the binder		
3.	Viscosity in Sec.		

VISCOSITY TEST

AIM: To determine the viscosity of given bituminous material.

APPARATUS: A orifice viscometer (one of 4.0mm diameter used to test cut back grades 0 and 1 and 10mm orifice to test all other grades), water bath, stirrer and thermometer.

THEORY: Viscosity of a fluid is the property by virtue of which it offers resistance to flow. Higher the viscosity, the slower will be the movement of the liquid. The viscosity affects the ability of the binder to spread, move into, & fill up the voids between aggregates. It also place on important. Role in coating of aggregates. Highly viscous binder may not fill up the voids completely there by resulting in poor density of the mix. At lower viscosity the binder does not hold the aggregates together but just acts as lubricant the viscosity of bituminous binders falls very rapidly as the temperature rises since binders exhibit viscosity over a wider range, it is necessary to use different methods for the determination of viscosity for binder in the liquid state (Road tars & cutback bituminous),the viscosity is determined as the time in sec. by 50cc of the material to flow from a cup through specified orifice under standard conditions to test & at specified temperature. Equipment like sliding plate micro viscometer, & brook field viscometer are however in used for defining the viscous characteristics of the bitumen of all grades irrespective of testing temperature.

PROCEDURE:

1. Adjust the tar viscometer so that the top of the tar cup is leveled select the test temp. From table1. Heat the water in the water bath to the temp. Specified for the test & maintain it with in $\pm 0.1^0$c of the specified temp. Throughout the duration of test. Rotate the stirrer gently at frequent intervals or continuously.
2. Clean the Tar cup, orifice of the viscometer with a suitable solvent and dry thoroughly.
3. Warm and stir the material under examination to 20^0c above the temp. Specified for test & cool while continuing the stirring.

4. When the temp. Falls slightly above the specified temp, pour the tar in to the cup until the leveling peg ion the valve rods is just immersed when the latter is vertical.
5. Pour in to the graduated receiver 20ml; of mineral oil or one %by weight, solution of soft soap & place it under with orifice of the cup.
6. Place the other thermometer in the tar & stir until the temp. is with in $\pm 0.1^0$c of the specified temp. When this temp. Has been reached .suspended the thermometer coaxially with the cup & with its bulb approximately at the geometric center of the tar.
7. Hallow the assembled apparatus to stand for 5 min. during which period the thermometer reading should remain within 0.05^0c of the specified temp. Remove the temp. & quickly remove any excess tar so that the final level is on the central line on the leveling peg when the valve is in vertical position.
8. Lift the valve & suspend it on valve support
9. Start the stop watch when the reading in the cylinder is 25ml & stop when it is 75ml, note the time in sec.
10. Report the viscosity as the time taken in sec. by 50 ml. of tar to flow out at the temp. Specified for the test.

PRECAUTIONS:

a. The tar cup should be cleaned thoroughly with non- corroding solvents such as light tar oils free from phenols.
b. The orifice seize should be tested at frequent intervals with a gauge having a appropriate diameters.

RESULT



MARSHALLA STABILITY APPARATUS

BITUMINOUS MIX DESIGN BY MARSHALL METHOD

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, loading machine flow meter, thermometers water bath and oven

THEORY

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

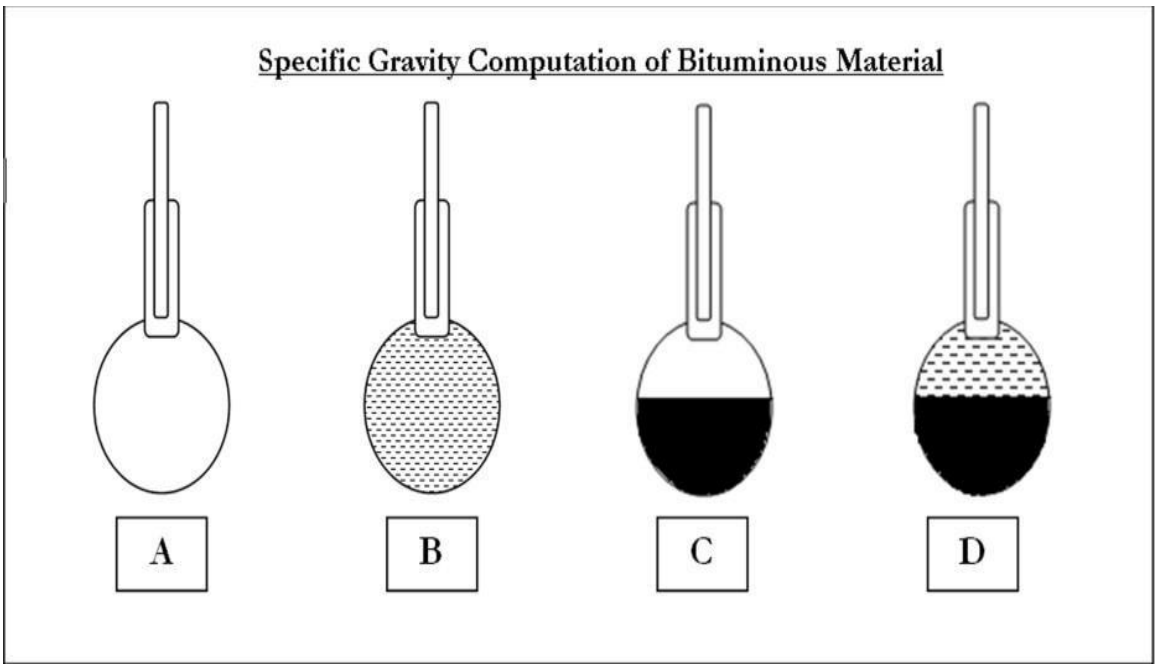
PROCEDURE:

1. The coarse aggregates, fine aggregates and mineral filler material should be proportioned and mixed in such a way that final mix after blending has the graduation within the specified range.
2. Approximately 1200 grams of aggregates and filler are taken and heated to a temperature of 175^{o}C to 195^{O} C.

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

3. Then the mix is heated and a temperature of 150_o to 160_oC is maintained and then the mix is transferred into the pre-heated mould and compacted by giving seventy five blows on each side.
4. The specific gravity values of different aggregates, filler and bitumen used are determined first. The theoretical specific gravity of the mix is determined.
5. Soon after the compacted bituminous mix specimens have cooled to room temperature, the weight, average thickness and diameter of the specimen are noted. The specimens are weighted in air and then in water.
6. The bulk density value of the specimen if calculated from weight and volume
7. Then the specimen to be tested is kept immersed under water in a thermostatically controlled water bath maintained at $60^0 \pm 1^0C$ for 30 to 40 minutes.
8. The specimens are taken out one, placed in the marshal test and the marshal stability value and flow are noted.
9. The corrected Marshall Stability value of each specimen is determined by applying the appropriate correction factor, if the average height of the specimen is not exactly 63.5mm.
10. 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.
11. Let the bitumen contents corresponding to maximum density be B_1, corresponding tomaximum stability be B_2 and that corresponding to the specified voids content (at 4.0%)be B_3. Then the optimum bitumen content for mix design is given by: $B_o = (B_1+B_2+B_3)/3$

RESULT: The optimum binder content of the given mix is…….



CALCULATION

The specific gravity of the bituminous material is calculated as follows:

(i) Pyknometer method

$$\text{Specific gravity} = \frac{\text{weight of bituminous material}}{\text{Weight of equal volume of wate at27°C}} = \frac{(c-a)}{(b-a)-(d-c)}$$

a = weight of specific gravity bottle

b = weight of the specific gravity bottle filled with distilled water

c = weight of the specific gravity bottle about half filled with bituminous material.

d = weight of the specific gravity bottle about half filled with the material and the rest with distilled water.

SPECIFIC GRAVITY TEST

AIM: To determine the specific gravity of given sample of water.

APPARATUS: There are two methods (i) Pycnometer method (ii) Balance method. For pycnometer method, the apparatus are specific gravity bottle of 50 ml capacity, ordinary capillary type with 6 mm diameter neck or wide mouthed capillary type bottle with 25 nm

diameter neck can be used. For balance method an analytical balance equipped with a pan straddle is used.

PROCEDURE:

The specific gravity bottle is cleaned, dried arid weighed along with the stopper. It is filled with fresh distilled water, stopper placed and the same is kept in water container 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.

The bituminous material is heated to a pouring temperature and is poured in the above empty bottle taking all the precautions that it is dean and dry before filling sample materials. The material is filled upto the half taking care to prevent entry of air bubbles. To permit an escape of air bubbles, the sample bottle is allowed to stand for half an hour at suitable temperature cooled to 27°C and then weighed. The remaining space in the specific gravity bottle is filled with distilled water at 27°C, stopper placed and is, placed in water container at 27°C. The bottle containing bituminous material and containing water is removed, cleaned from outside and is again weighed.

STANDARDS

The Indian Standard institution specifies that the minimum specific gravity values of paving bitumen at 27°C shall be 0.99 for grades A 25, A 35, A 45, A 65, S 35, S 45, and S 65, 0.98 for A 0 and S 90 and 0.97 for A 200 and S 200. (For classification of bitumen, see Table under Experiment No. 17, ‘Applications of penetration test).

RESULT

CALIFORNIA BEARING RATIO TEST

AIM: To determine the California bearing ratio by conducting a load penetration test in the laboratory.

APPARATUS:

1.Cylindricalmould with inside dia 150 mm and height 175 mm, provided with a detachable extension collar 50 mm height and a detachable perforated base plate 10 mm thick.

2.Spacer disc 148 mm in dia and 47.7 mm in height along with handle.

3Metal rammers. Weight 2.6 kg with a drop of 310 mm (or) weight 4.89 kg a drop 450 mm.

4.Weights. One annular metal weight and several slotted weights weighing 2.5 kg each, 147 mm in dia, with a central hole 53 mm in diameter.

5.Loading machine. With a capacity of atleast 5000 kg and equipped with a movable head or base that travels at an uniform rate of 1.25 mm/min. Complete with load indicating device.

6.Metal penetration piston 50 mm dia and minimum of 100 mm in length.

7.Two dial gauges reading to 0.01 mm.

8.Sieves. 4.75 mm and 20 mm I.S. Sieves.

9.Miscellaneous apparatus, such as a mixing bowl, straight edge, scales soaking tank or pan, drying oven, filter paper and containers.

DEFINITION OF C.B.R. It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material.

C.B.R. = Test load/Standard load * 100

The following table gives the standard loads adopted for different penetrations for the standard material with a C.B.R. value of 100%

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

The test may be performed on undisturbed specimens and on remoulded specimens which may be compacted either statically or dynamically.

PREPARATION OF TEST SPECIMEN Undisturbed specimen Attach the cutting edge to the mould and push it gently into the ground. Remove the soil from the outside of the mould which is pushed in . When the mould is full of soil, remove it from weighing the soil with the mould or by any field method near the spot.

Determine the density

Remoulded specimen Prepare the remoulded specimen at Proctors maximum dry density or any other density at which C.B.R> is required. Maintain the specimen at optimum moisture content or the field moisture as required. The material used should pass 20 mm I.S. sieve but it should be retained on 4.75 mm I.S. sieve. Prepare the specimen either by dynamic compaction or by static compaction.

Dynamic Compaction Take about 4.5 to 5.5 kg of soil and mix thoroughly with the required water.

Fix the extension collar and the base plate to the mould. Insert the spacer disc over the base.

Place the filter paper on the top of the spacer disc.

Compact the mix soil in the mould using either light compaction or heavy compaction. For light compaction, compact the soil in 3 equal layers, each layer being given 55 blows by the 2.6 kg rammer. For heavy compaction compact the soil in 5 layers, 56 blows to each layer by the 4.89 kg rammer.

Remove the collar and trim off soil.

Turn the mould upside down and remove the base plate and the displacer disc.

Weigh the mould with compacted soil and determine the bulk density and dry density.

Put filter paper on the top of the compacted soil (collar side) and clamp the perforated base plate on to it.

Static compaction

Calculate the weight of the wet soil at the required water content to give the desired density when occupying the standard specimen volume in the mould from the expression. W =desired dry density * (1+w) V

Where W = Weight of the wet soil

w = desired water content

V = volume of the specimen in the mould = 2250 cm3 (as per the mould available in laboratory)

Take the weight W (calculated as above) of the mix soil and place it in the mould.

Place a filter paper and the displacer disc on the top of soil.

Keep the mould assembly in static loading frame and compact by pressing the displacer disc till the level of disc reaches the top of the mould.

Keep the load for some time and then release the load.

Remove the displacer disc. The test may be conducted for both soaked as well as un soaked conditions.

If the sample is to be soaked, in both cases of compaction, put a filter paper on the top of the soil and place the adjustable stem and perforated plate on the top of filter paper.

Put annular weights to produce a surcharge equal to weight of base material and pavement expected in actual construction. Each 2.5 kg weight is equivalent to 7 cm construction. A minimum of two weights should be put.

Immerse the mould assembly and weights in a tank of water and soak it for 96 hours. Remove the mould from tank. Note the consolidation of the specimen.

Procedure for Penetration Test Place the mould assembly with the surcharge weights on the penetration test machine. Seat the penetration piston at the center of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample is established. Set the stress and strain dial gauge to read zero. Apply the load on the piston so that the penetration rate is about 1.25 mm/min.

Record the load readings at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 and 12.5 mm. Note the maximum load and corresponding penetration if it occurs for a penetration less than 12.5 mm. Detach the mould from the loading equipment. Take about 20 to 50 g of soil from the top 3 cm layer and determine the moisture content.

Penetration Dial	Load Dial	Corrected Load

Interpretation and recording

C.B.R. of specimen at 2.5 mm penetration

C.B.R. of specimen at 5.0 mm penetration

NON-DESTRUCTIVE TESTING OF CONCRETE

REBOUND HAMMER TEST

AIM: To determine the compressive strength of concrete by using the rebound hammer.

APPARATUS:

- Rebound Hammer instrument.
- Abrasive Stone

PROCEDURE:

Hold the instrument firmly so that the plunger is perpendicular to the test surface. Gradually push the instrument toward the test surface until the hammer impacts. After impact, maintain pressure on the instrument and if necessary depress the button on the side of the instrument to lock the plunger in its retracted position. Read the rebound number on the scale to the nearest whole number and record the rebound number. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm (1 in). Examine the impression made on the surface after impact, and if the impact crushes or breaks through a near-surface air void, disregard the reading and take another reading.

READING YOUR RESULTS:

Make at least ten readings from a concrete surface and discard the highest and lowest rebound numbers. Average the remaining eight numbers. If desired, take a few test readings before you complete your series of ten regular tests. Use the average rebound number to estimate the strength of the concrete. Compare your average rebound number to the chart shown on your Concrete Rebound Hammer.

Average Rebound Number	Quality of Concrete
>40	Very good hard layer
30 to 40	Good layers
20 to 30	Fair
<20	Poor concrete

ULTRASONIC PULSE VELOCITY

AIM

To assess the quality of concrete by ultrasonic pulse velocity method
as per IS: 13311 (Part 1) - 1992.

PRINCIPLE

The method consists of measuring the time of travel of an ultrasonic pulse passing through the concrete being tested. Comparatively higher velocity is obtained when concrete quality is good in terms of density, uniformity, homogeneity etc.

APPARATUS: ULTRASONIC PULSE VELOCITY METER

PROCEDURE

i) Preparing for use: Before switching on the 'V' meter, the transducers should be connected to the sockets marked "TRAN" and " REC". The 'V' meter may be operated with either:
a) the internal battery,
b) an external battery or
c) the A.C line.

ii) Set reference: A reference bar is provided to check the instrument zero. The pulse time for the bar is engraved on it. Apply a smear of grease to the transducer faces before placing it on the opposite ends of the bar. Adjust the 'SET REF' control until the reference bar transit time is obtained on the instrument read-out.

iii) Range selection: For maximum accuracy, it is recommended that the 0.1 microsecond range be selected for path length upto 400mm.

iv) Pulse velocity: Having determined the most suitable test points on the material to be tested, make careful measurement of the path length ‘L’. Apply couplant to the surfaces of the transducers and press it hard onto the surface of the material. Do not move the transducers while a reading is being taken, as this can generate noise signals and errors in measurements. Continue holding the transducers onto the surface of the material until a consistent reading appears on the display, which is the time in microsecond for the ultrasonic pulse to travel the distance
'L'. The mean value of the display readings should be taken when the units digit hunts between two values.

Pulse velocity =Path length/Travel time

v) Separation of transducer leads: It is advisable to prevent the two transducer leads from coming into close contact with each other when the transit time measurements are being taken. If this is not done, the receiver lead might pick-up unwanted signals from the transmitter lead and this would result in an incorrect display of the transit time.

INTERPRETATION OF RESULTS

The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation, etc., indicative of the level of workmanship employed, can thus be assessed using the guidelines given below, which have been evolved for characterizing the quality of concrete in structures in terms of the ultrasonic pulse velocity.

Pulse Velocity (km/second)	Concrete Quality (Grading)
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Doubtful

WATER PERMEABILITY OF HARDENED CONCRETE

SCOPE This test covers the laboratory determination of the D'Arcy coefficient of water permeability of hardened concrete specimens using a Concrete Permeameter. The samples are either cored from existing concrete structures or taken from moulded cylindrical specimens.

DEFINITION D'Arcy demonstrated in the late nineteenth century that for laminar flow conditions in saturated granular materials, the rate of flow is proportional to the pressure gradient (q = ki). The D'Arcy coefficient of permeability is the constant of proportionality between volume flow (q) and pressure gradient (i) and can be interpreted as the average velocity of flow through the sample cross section.

APPARATUS

1. A permeameter cell which can maintain a seal over the circumference of a saturated cylindrical concrete specimen and which is capable of operating effectively under pressures of up to 1000kPa.

A means of supplying de-aired water to the top surface of the concrete specimen contained within the permeameter cell at a constant pressure head of up to 1000kPa.
A pressure gauge to measure input pressure and a thermometer to measure ambient temperature.
Data acquisition equipment to record, at suitable intervals of time, the pressure, volumetric flow of water into and out of the concrete specimen and the ambient temperature.

2. Diamond cut saw.
3. Balance of suitable capacity readable to 0.1g with a limit of performance of not more than 0.6g at the 99% confidence level.
4. Supply of de-aired water.
5. Vacuum pump.
6. Vernier callipers.
7. Diamond corer drill.
8. 100mm diameter concrete mould complying with AS 1012.8.
9. Worksheet (optional). A graphical representation of the data, including the calculation of the D'Arcy Coefficient of Permeability is suitable.

PROCEDURE

1. Obtain samples of hardened concrete of appropriate diameter from existing structures by diamond core drilling or from molded specimens. The specimens shall be prepared in accordance with AS 1012. Using a diamond saw, cut a section of the sample to allow approximately 2mm clearance at each end of the Room Temperature Vulcanizing (RTV) silicone rubber seal. The test sample should have a minimum length of 2.5 times the maximum aggregate size. The cut section will be the test sample.

2. Condition the test sample in accordance with AASHTO T277 to a Saturated Surface Dry state, deleting the section referring to the use of epoxy resins.
3. Fill the voids that are 2mm or greater in diameter that occur on the sides of the test sample with plasticine or a similar material.
4. Measure and record the mass of the test sample to the nearest 0.1g and the diameter (D) and length (L) of the sample to the nearest 1mm.
5. Seal the test sample within the permeameter cell. (See Appendix A).
6. Ensure that the permeameter apparatus is completely filled with de-aired water and contains no air pockets or bubbles.
7. Apply a constant pressure head of water to the inflow side of the permeameter cell and continuously monitor the pressure throughout the duration of the test.
8. Continuously monitor and record the volumetric inflow and outflow of water.
9. Continuously monitor and record the ambient temperature, to the nearest 0.1°C. Ensure that the temperature is maintained within a range of 21 to 25°C.
10. After steady state flow through the sample has been achieved, monitor and plot volume flow (Q) against time (t) until the slope of the inflow and outflow lines can be achieved. Calculate the permeability by taking the mean of the inflow and outflow plots within the steady state flow range.
11. NOTE: This test is designed to determine the order of magnitude for concrete permeability. A variation between the inflow and outflow slopes of up to 20% will not significantly affect the outcome.
12. Remove the test sample from the apparatus and measure and record the mass of the test sample to the nearest 0.1g.

COEFFICIENT OF PERMEABILITY

1. Determine the cross sectional area (A) in square metres of the test sample using the following formula: ($A= \pi * D^2 / 4$) where D = Diameter of test sample, to the nearest 0.001m.
2. Determine the applied pressure head (h) in metres of water.
3. The D'Arcy Coefficient of Permeability is calculated using the following formula:

$$K = QL / tAh$$

where k = D'Arcy Coefficient of Permeability (m/s) Q = Volume of water in m3 L = Length of the test sample in metres, to the nearest 0.001mt = Elapsed time in seconds h = Applied pressure head in metres of water A = Area of the test sample in m^2

APPENDIX A

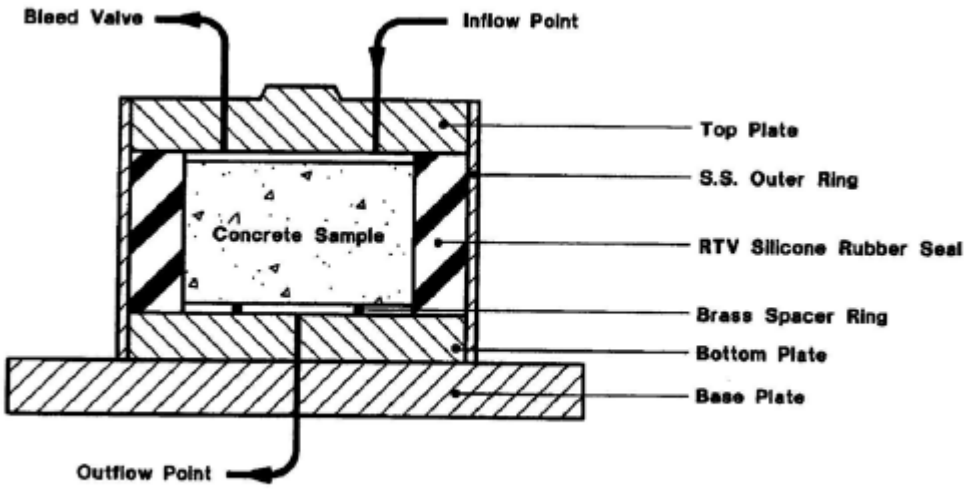
MILLS AND HEARN PERMEAMETER RIG OPERATOR MANUAL

1. Place the brass spacer ring centrally on the permeameter cell bottom plate.
2. Select an appropriate diameter RTV silicone rubber seal with an internal diameter to match the test sample diameter and place in the outer ring of the cell.
3. NOTE: The test sample must be a snug fit in the RTV silicone rubber seal. The test sample should also be 4 - 6mm less in height than the RTV silicone rubber seal.
4. Push the test sample through the RTV silicone rubber seal until it contacts the brass ring leaving approximately 2 – 3mm space between the test sample and the bottom plate. Ensure that the outflow valve is open at this stage to allow water and air to be expelled.
5. NOTE: Outflow valve is at the vacuum pump connection.
6. Fill the space on top of the test sample with de-aired water to the top of the RTV silicone rubber seal.
7. Position the top plate in the cell and clamp down with the screw jack. Clamp down the side lever cam of the cell to ensure a tight seal. Bleed valve on lid should be open at this time.
8. Connect a suitable vacuum pump to the outflow valve and evacuate the outflow line to the base of the cell. Allow the pump to run for several minutes.
9. Close the outflow valve and remove the vacuum pump.
10. Let water into the cell outflow line via the reservoir and by-pass line.
11. Close all taps on outflow and by-pass line.
12. Bleed all air out of the top of the cell. This can be achieved by forcing water, using the utility piston, into the top of the cell and out again into the reservoir, closing the bleed valve at the end of each stroke
13. NOTE: Check that the movement of the utility piston is within normal limits as a check for air in the inflow lines.
14. Repeat this operation until no further air is expelled from the cell. Close the bleed valve and all other valves. The system is now ready for pressurization of the inflow (top) side of the cell. The applied pressure must not exceed 1000kPa.
15. This is best done in two stages to ensure minimal movement of the inflow cylinder.

Initial Pressure Using hanging (say 20Kg) weights on the utility piston to initially pressurize the system to approximately 800kPa, opening the taps to the cell and utility piston. 12.2 Turn on the pneumatic pressure, adjust to approximately 800kPa, and open the line to take over the applied pressure to cell. Close the tap to the utility piston and remove the weights.

16. Allow the pressure to stabilize and adjust the inflow and outflow cylinders to near the start of their movement range. NOTE: Unexpected changes in flow direction can occur during test due to temperature changes and internal suctions within the test sample. Allowance should be made in setting the cylinders for these movements.
17. Open inflow and outflow valves.

18. Check for leaks, or even air bubbles in the system (air bubbles can be compressed which show up as apparent inflow). Leakage of the system will be apparent almost immediately on checking the cell and de-aired water lines.
19. Press down firmly on the inflow cylinder and also the outflow cylinder. They should feel
n and repeat the set-up



estarted).
ned, then continue the
Q versus t plot.
. A highly permeable
low permeability may
according to expected
ours advice should be

VIVA QUESTIONS

1) What is normal consistency of cement paste?
2) What is purpose of making this determination?
3) How is the standard or normal consistency expressed?
4) What is range of values most for Portland cement
5) What is meaning of Consistency in concrete?
6) What is slump of concrete?
7) What is the significance of shear slump?
8) What is segregation?
9) What is the difference is between fully compacted and partially compacted concrete?
10) What is the significance of compacted concrete?
11) Define density of concrete & how it affects the strength of concrete?
12) Describe the factors affecting the choice of the method of test.
13. What are the advantages and disadvantages of Vee-Bee method of test over the other? Methods
14. How does strength correlate with other properties of hardened concrete?
15. What are the requirements for curing the specimens?
16. What do you mean by elongation index of an aggregate?
17. What do you infer from elongation index?
18. How the elongation index of the sample helps in deciding the design of a highway?
19. What do you mean by flakiness index of an aggregate?
20. What do you infer from flakiness index?
21. How the flakiness index of the sample helps in deciding the design of a highway?

22. How is the crushing strength test carried out on cylindrical stone specimen? Why is the test not carried out commonly?

23. Explain aggregate crushing value. How would you express?

24. Briefly explain the aggregate crushing value test procedure.

25. What is the specified standard size' of aggregates? How is the aggregate crushing value of non standard size aggregate evaluated?

26. Aggregate crushing value of material A is 40 and that of B is 25. Which one is better and why?

27. What are the applications of aggregate crushing test?

28. What are the recommended maximum values of aggregate crushing value for the aggregates to be used in base and surface courses of cement concrete?

29. What are the uses and applications of the aggregate crushing test?

30. Why Los Angeles abrasion test is considered superior to other tests to find the hardness of aggregates?

31. How is Los Angeles abrasion value expressed?

32. The abrasion value found from Los Angeles test for aggregates A and B are 35 and 15 respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?

33. Briefly explain the Los Angeles abrasion test procedure.

34. What are the desirable limits of Los Angeles Abrasion values specified for different types of pavement surfacing?

35. What are the advantages of Aggregate Impact test over Page Impact test?

36. Briefly mention the procedure of aggregate impact test?

37. How is aggregate impact expressed?

38. What are the desirable limits of aggregate impact value specified for different types of pavement surfaces?

39. Aggregate impact value material A is 20 and that of B is 45. Which one is better for surface course? Why?

40. What do you understand by dry and wet impact value?
41. How is penetration value of bitumen expressed?
42. What are the standard load, time and temperature specified for penetration test.
43. Briefly outline the penetration test procedure.
44. What do you understand by 80/ 100 bitumen?
45. What are the effects of: (i) higher test temperature (ii) higher pouring temperature (iii) Exposed bitumen, on penetration test results.
46. Explain ductility of Bitumen and its significance.
47. How is ductility value expressed?
48. Outline the ductility test procedure.
49. What is the minimum area of cross section of the ductility specimen?
50. What are the precautions to be taken while finding the ductility value?
51. What are the factors affecting the ductility test results?
52. What is softening point?
53. What does softening point of bituminous materials indicate?
54. What are the applications of ring and ball test results?
55. Explain the two methods of finding specific gravity of bituminous materials.
56. What precautions should be taken while finding the specific gravity?
57. What are the applications of specific gravity and results?
58. Explain the term viscosity.
59. What are the different methods in determining the viscous characteristics of bituminous materials?
60. What is absolute unit for viscosity?
61. What are the uses of viscosity test?

62. Write a note on float test.

63. What are the precautions to be taken during viscosity test using orifice viscometer?

64. Define flash and fire points.

65. Briefly outline the flash point test procedure.

66. What is the significance of flash point test. Differentiate between flash point and fire point.

67. Why do we need to design bituminous mix?

68. What are the essential properties of bituminous mixes?

69. What is the significance of flow value in Marshall test?

70. Why is the sample in Marshall test placed on its periphery while loading?

71. What is the measure taken if a mix results in excessive voids?

72. What is filler?

73. What are different types of fillers?

74. Does Portland cement, if used in bituminous mix, improve strength?

75. Briefly out line Marshall Stability test procedure?

76. How is bituminous mixed designed based on Marshall design approach?

Reference codes

Sl No	Experiments	Codes
1	Normal Consistency Of Cement	(IS: 4031 - 1988 - 4))
2	Initial And Final Setting Times Of Cement	(IS: 4031- 1988 -5)
3	Specific Gravity Of Cement	(IS: 4031-1988)
4	Soundness Of Cement	(IS 4031-1988 PART 3)
5	Compressive Strength Of Cement	(IS 269-1989, IS 8112-1989, IS 12269 - 1987, IS 4031-1988 (Part6)
6	Slump Test	(IS 1199-1959)
7	Compaction Factor Test	(IS 1199-1959)
8	Vee-Bee Consistometer	(IS 1199-1959)
9	Test For Compressive Strength Of Concrete Cubes	(IS: 516 – 1959)
10	Split Tensile Strength Of Concrete	(IS: 5816 – 1999)
11	Aggregate Crushing Value Test	(IS 2386- part IV)
12	Aggregate Impact Test	(IS 2386- part IV)
13	Abrasion Test	(IS 2386- part IV)
14	Shape Test	(IS 2386- part I)
15	Softening Point Test	(IS1205-1978)
16	Viscosity Test	(IS1206-1978)
17	Ductility Test	(IS1207-1978)
18	Flash & Fire Point Test	(IS 1209-1978)
19	Specific Gravity of Bitumen	(IS 1202-1978)
20	Penetration Test	(IS1203-1978)