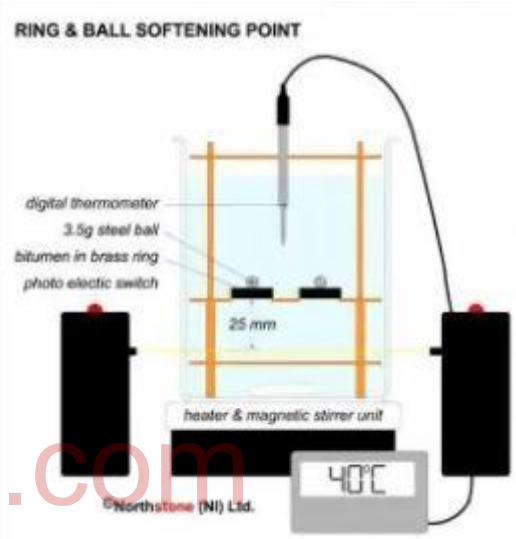
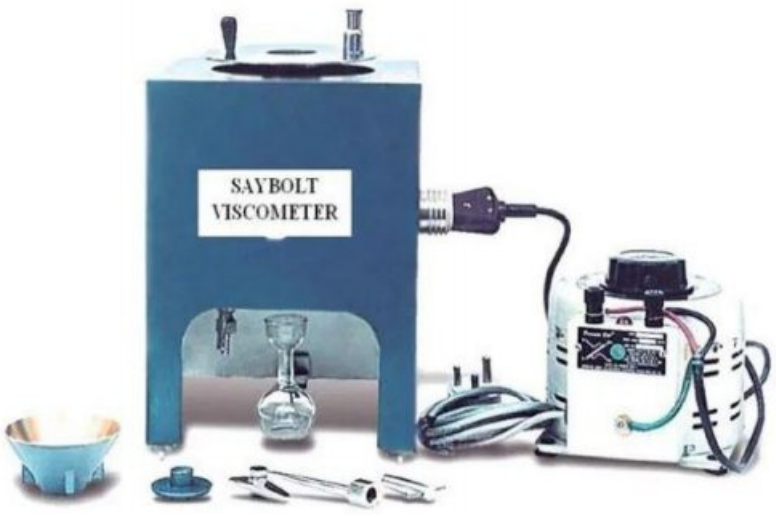
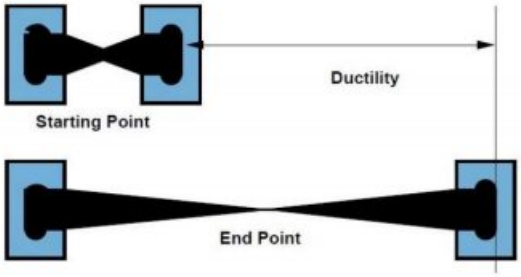
JP College of Engineering
Run by DMI Sisters
Affiliated to Anna University, Chennai & Approved by AICTE, New Delhi,
ISO 9001:2015 Certified
Ayikudy-627852, Tenkasi (Dist), Tamil Nadu, India.

CE 3511 HIGHWAY ENGINEERING LABORATORY

Regulation 2021







G. BASKAR SINGH

INSTITUTE VISION:

To evolve as Centre of Excellence in Teaching, Innovative Research and consultation in Engineering and Technology and to empower the rural youth with technical knowledge and professional competence thereby transposing them as globally competitive and self-disciplined technocrats.

INSTITUTE MISSION:

To inculcate technical knowledge and soft skills among rural students through student-centric learning process and make them as competent engineers with professional ethics to face the global challenges, thus bridging the 'rural-urban divide'.

INSTITUTE QUALITY POLICY

To develop the college into a global institute of Learning.

- Research and consultation in Engineering and Technology with high standard of academic excellence.
- To serve the institute with total commitment, dedication, team spirit and quality conscious in teaching and training the students.
- To empower the rural youth with technical knowledge and professional competence and thereby bridging the barrier between rural and urban
- To mould the students as citizens with moral, ethical and social values so as to fulfill their obligations to the society and nation at large.

DEPARTMENT VISION & MISSION STATEMENT

VISION:

To build young Technocrats by imparting their technical knowledge in the field of Civil Engineering, by laying the foundation for future engineers, who can meet the demands of industry and community effectively in all part of civil works and to make significant contribution in the economic development of the state, region and nation.

MISION:

M1: To adopt valuable teaching methods and implement high quality education to maximize Engineering knowledge for students.

M2: To promote innovative and original thoughts in the minds of civil engineers.

M3: To provide facilities to the students and faculty members to enhance the understanding and implementation of recent trends in the Civil Engineering field.

M4: To produce Civil Engineering graduates with good ethical skills and managerial skills to become as successful professionals and entrepreneurs.

M5: To promote advanced technology, Industry Institute interaction, research and consultancy in Civil Engineering department with global linkages.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the programme B E Civil Engineering will

PEO I. Gain knowledge and skills in Civil engineering which will enable them to have a career and professional accomplishment in the public or private sector organizations

PEO II. Become consultants on complex real life Civil Engineering problems related to Infrastructure development especially housing, construction, water supply, sewerage, transport, spatial planning.

PEO III. Become entrepreneurs and develop processes and technologies to meet desired infrastructure needs of society and formulate solutions that are technically sound, Economically feasible, and socially acceptable.

PEO IV. Perform investigation for solving Civil Engineering problems by conducting research using modern equipment and software tools.

PEO V. Function in multi-disciplinary teams and advocate policies, systems, processes and equipment to support civil engineering

PROGRAM OUTCOMES (POs)

PO# Graduate Attribute

1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of Mathematics, natural sciences, and engineering sciences.

3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6 **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 Knowledge of Civil Engineering discipline

Demonstrate in-depth knowledge of Civil Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge.

PSO2 Critical analysis of Civil Engineering problems and innovation

Critically analyze complex Civil Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

PSO3 Conceptualization and evaluation of engineering solutions to Civil Engineering

Issues Conceptualize and solve Civil Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio cultural factors

CE3511 HIGHWAY ENGINEERING LABORATORY **L T P C**

0 0 4 2

COURSE OBJECTIVE:

To learn the principles and procedures of testing of materials used in the construction of highways.

EXCERCISES:

I TEST ON AGGREGATES

1. Specific gravity determination of the coarse aggregate sample
2. Determination of abrasion value of the coarse aggregate sample.
3. Determination of water absorption capacity of the coarse aggregate sample

II TEST ON BITUMEN

4. Specific gravity determination of the bitumen/asphalt sample.
5. Determination of consistency of the bituminous material.
6. Viscosity determination of bituminous binder.
7. Determination of softening point of the asphalt/bitumen sample
8. Determination of ductility value of the bitumen sample
9. Estimation of loss of bitumen on heating
10. Determination of optimum binder content by Marshall method

III BITUMINOUS MIXES

11. Determination of stripping value of the bituminous mix Demonstration
12. Determination of bitumen content in the bituminous mix by cold solvent extraction method

TOTAL: 60 PERIODS

COURSE OUTCOMES

CO1 Characterize Pavement Aggregate through relevant test.

CO2 Ascertain the Quality of Bitumen.

CO3 Determine the Optimum Binder Content Using Marshall Method.

CO4 Evaluate the Consistency and Properties of Bitumen.

CO5 Determine the Bitumen Content in the Bituminous Mixes

REFERENCES

1. Highway Materials and Pavement Testing, Nem Chandand Bros.,Roorkee, Revised Fifth Edition, 2009

2. N.L.Arora,A Textbook of Transportation Engineering, New India Publication,1997

3.http://vlabs.iitb.ac.in/vlabsdev/labs/nitk_labs/Transportation_Engineering_Lab/index.html

4. Laboratory Manual in Highway engineering published, Duggal,Ajay K 2017

COs- PO's & PSO's MAPPING

PROGRAMOUTCOMES(PO)PO/PSO		Course Outcome					Over all Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PROGRAM OUTCOMES(PO)							
PO1	Knowledge of Engineering Sciences	**3**	**3**	**3**	**3**	**3**	**3**
PO2	Problem analysis	**1**	**1**	**1**	**1**	**1**	**1**
PO3	Design / development of solutions	**3**	**3**	**3**	**3**	**3**	**3**
PO4	Investigation	**2**	**2**	**2**	**2**	**2**	**2**
PO5	Modern Tool Usage	**1**	**1**	**1**	**1**	**1**	**1**
PO6	Engineer and Society	**1**	**1**	**1**	**1**	**1**	**1**
PO7	Environment and sustainability	**1**	**1**	**1**	**1**	**1**	**1**
PO8	Ethics	**1**	**1**	**1**	**1**	**1**	**1**
PO9	Individual and Team work	**3**	**3**	**3**	**3**	**3**	**3**
PO10	Communication	**3**	**3**	**3**	**3**	**3**	**3**
PO11	Project Management and Finance	**1**	**1**	**1**	**1**	**1**	**1**
PO12	Life Long Learning	**3**	**3**	**3**	**3**	**3**	**3**
PROGRAM SPECIFIC OUTCOMES (PSO)							
PSO1	Knowledge of Civil Engineering discipline	**3**	**3**	**3**	**3**	**3**	**3**
PSO2	Critical analysis of Civil Engineering problems and innovation	**3**	**3**	**3**	**3**	**3**	**3**
PSO3	Conceptualization and evaluation of engineering solutions to Civil Engineering Issues	**2**	**2**	**2**	**2**	**2**	**2**

GENERAL INSTRUCTIONS

The following instructions should be strictly followed by the students in the Highway Engineering Laboratory

- Students should enter the lab with proper uniform and ID card.
- Always keep work areas clean and tidy.
- Observe safety alerts in the laboratory.
- Always wear shoes that completely cover your feet. No sandals or opened toed shoes are allowed.
- Follow all written and verbal instructions carefully.
- Observe the safety alerts in the laboratory.
- Don't forget to bring Lab manual, Record, observation, calculator, graph sheet and other accessories when you come to lab.
- In the absence of Instructor, no student shall be allowed to work in the laboratory.
- Don't use mobile phones during lab hours.
- Place tools and equipment in proper place after use.
- Turn off the power switches of weighing balance and equipment's after used.
- Report to the staff if any injuries.
- Don't try to repair any faulty instruments.

EX. NO:	DATE	LIST OF EXPERIMENTS	Marks	Staff Sign.
		TEST ON AGGREGATES		
1.		Specific Gravity Determination of The Coarse Aggregate Sample		
2.		Determination of Abrasion Value of The Coarse Aggregate Sample		
3.		Determination of Water Absorption Capacity of The Coarse Aggregate Sample		
		TEST ON BITUMEN		
4.		Specific Gravity Determination of The Bitumen/Asphalt Sample.		
5.		Determination of Consistency of The Bituminous Material.		
6.		Viscosity Determination of Bituminous Binder.		
7.		Determination of Softening Point of The Asphalt/Bitumen Sample		
8.		Determination of Ductility Value of The Bitumen Sample		
9.		Estimation of Loss of Bitumen on Heating		
10.		Determination of Optimum Binder Content by Marshall Method		
		BITUMINOUS MIXES		
11.		Determination of Stripping Value of The Bituminous Mix Demonstration		
12.		Determination of Bitumen Content in The Bituminous Mix by Cold Solvent Extraction Method		
13.		Model Lab Examination		

EX.NO:1	Specific Gravity Determination of The Coarse Aggregate Sample
DATE:	

AIM

To determine the specific gravity on Coarse Aggregate.

APPARATUS REQUIRED

- Balance
- Sample Container
- 5mm Sieve
- Suitable oven or stove for drying sample
- Sample splitter
- Large Absorbant Cloth

PROCEDURE

1. After thoroughly washing to remove dust or other coatings from the surface of the particles, dry the sample to constant weight at a temperature of 100 to 110° C, cool in air at room temperature for 1 to 3 hours and then immerse in water at room temperature for aperiod of 24 ± 4 hours.
2. **Note:** Where the absorption and specific gravity values are to be used in pro-partioning concrete mixtures in which the aggregates will be in their naturally moisture condition, the requirement for initial drying to constant weight may be eliminated.
3. Remove the specimen from the water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually. Take care to avoid evaporation of water from aggregate pores during the operation of surface-drying. Weigh the specimen in the saturated surface-dry condition. Record this and all subsequent weights to the nearest 0.5 g or 0.0001 times the sample weight, whichever is greater.
4. After weighing, immediately place the saturated surface-dry specimen in the sample container and determine its weight in water at 23 ± 1.7° C, having a density of 0.997 ± 0.002 g/cm^3. Take care to remove all entrapped air before weighing by shaking thecontainer while immersed.
5. Dry the specimen to constant weight at a temperature of 100 to 110° C. Cool in air at room temperature 1 to 3 hours and weigh.

RESULTS AND CALCULATIONS

1. Bulk Specific Gravity

Calculate the bulk specific gravity, 23/23^{o} C,

Bulk Specific Gravity = A/(B-C)

Where A = weight of oven-dry specimen in Air, g

B = weight of saturated surface-dry specimen in air, g

C = weight of saturated specimen in water, g

2. Bulk Specific Gravity (Saturated Surface-Dry Basis)

Calculate the bulk specific gravity, 23/23^{o} C, on the basis of weight of saturated surface-dry aggregate as follows:

Bulk Specific Gravity (saturated surface-dry basis) = B/(B-C)

Where: B = weight of saturated surface-dry specimen in air, g

C = weight of saturated specimen in water, g

3. Apparent Specific Gravity

Calculate the apparent specific gravity, 23/23^{o} C, as defined in Definitions E12 as follows:

Apparent Specific Gravity = A/(A-C)

Where: A = weight of oven-dry specimen in air, g

C = weight of saturated specimen in water, g

4. Absorption

Calculate the percentage of absorption, as defined in Definitions C125, as follows:

Absorption % = [(B-A)/A] x 100

Where A = weight of oven-dry specimen in air, g

B = weight of saturated surface-dry specimen in air, g

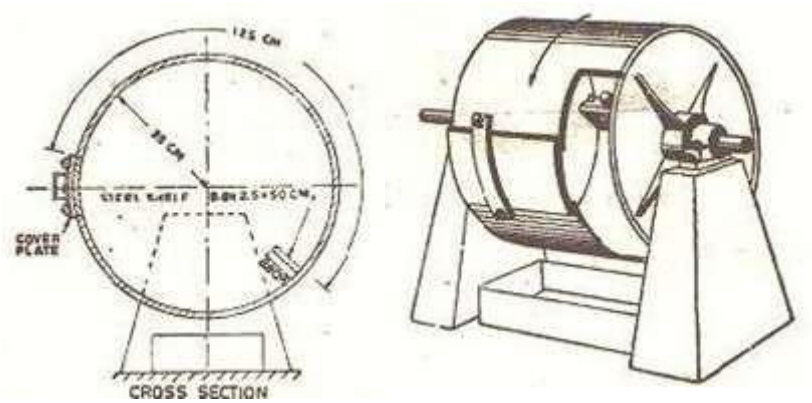
RESULTS

1. Bulk Specific Gravity =

2. Bulk Specific Gravity (saturated surface-dry basis) =

3. Apparent Specific Gravity =

4. Absorption % =



Los Angeles Abrasion Testing Machine

Observation and Calculation

Sl.no	Details of Sample	Trial 1	Trial 2	Average
1	Weight of sample = W1g			
2	Weight of sample after abrasion test, coarser than1.70mm IS sieve =W2g			
3	Percentage wear = ((W1 – W2)/W1)*100			

The Indian Standard (IS) code for the Los Angeles abrasion test is IS 383-1970. The following are the limitations of the Los Angeles abrasion test as per IS code:

- ✓ For aggregates to be used in wearing courses of concrete pavements, the maximum abrasion value should not exceed 30%.
- ✓ For aggregates to be used in other concrete, the maximum abrasion value should not exceed 50%.
- ✓ For aggregates to be used in water bound macadam (WBM), the maximum abrasion value should not exceed 40%.

EX.NO:2	Determination of Abrasion Value of The Coarse Aggregate Sample
DATE:	

Aim:

To determine the abrasion value of given aggregate sample by conducting Los Angles abrasion test.

Apparatus required:

Los Angles apparatus, IS Sieve, Weighting Balance.

Procedure:

1. Clean and dry aggregate sample confirming to one of the grading A to G is used for the test.
2. Aggregate weighing 5kg for grading A, B, C or D and 10Kg for grading E, F or G may be taken as test specimen and placed in the cylinder.
3. The abrasive charge is also chosen in accordance and placed in the cylinder of the machine, and cover is fixed to make dust tight.
4. The machine is rotated at a speed of 30 to 33 revolutions per minute.
5. The machine is rotated for 500 revolutions for grading A, B, C and D, for grading E, F and G, it shall be rotated for 1000 revolutions.
6. After the desired number of revolutions the machine is stopped and the material is discharged from the machine taking care to take out entire stone dust.
7. Using a sieve of size larger than 1.70mm IS sieve, the material is first separated into two parts and the finer position is taken out and sieved further on a 1.7mm IS sieve.
8. Let the original weight of aggregate be W1gm, weight of aggregate retained on 1.70mm IS sieve after the test be W2gm.

Result:

The average value of Los Angles Abrasion Test is_____%

EX.NO:3	Determination of Water Absorption Capacity of The Coarse Aggregate Sample
DATE:	

AIM:

To determine the water absorption of given coarse aggregate

APPARATUS REQUIRED:

Container, Balance, Electric Oven

PROCEDURE:

1) The coarse aggregate passing through IS 10mm sieve is taken about 200g.
2) They are dried in an oven at a temperature of 110^{o} $\pm 5^{o}$C for 24 hours.
3) The coarse aggregate is cooled to room temperature.
4) Its weight is taken as (W1g)
5) The dried coarse aggregate is immersed in clean water at a temperature 27^{o} $\pm 2^{o}$C for 24hours.
6) The coarse aggregate is removed from water and wiped out of traces of water with a cloth
7) Within three minutes from the removal of water, the weight of coarse aggregate W2 isfound out
8) The above procedure is repeated for various samples.

Observation and Calculation:

Sample No.	Weight of oven dried specimen (W1) g	Weight of saturated specimen (W2) g	Weight of water absorbed W3=(W2-W1) g	% of water absorption =(W3/W1) x 100

Weight of dry sample of coarse aggregate W1 =

Weight of saturated specimen W2 =

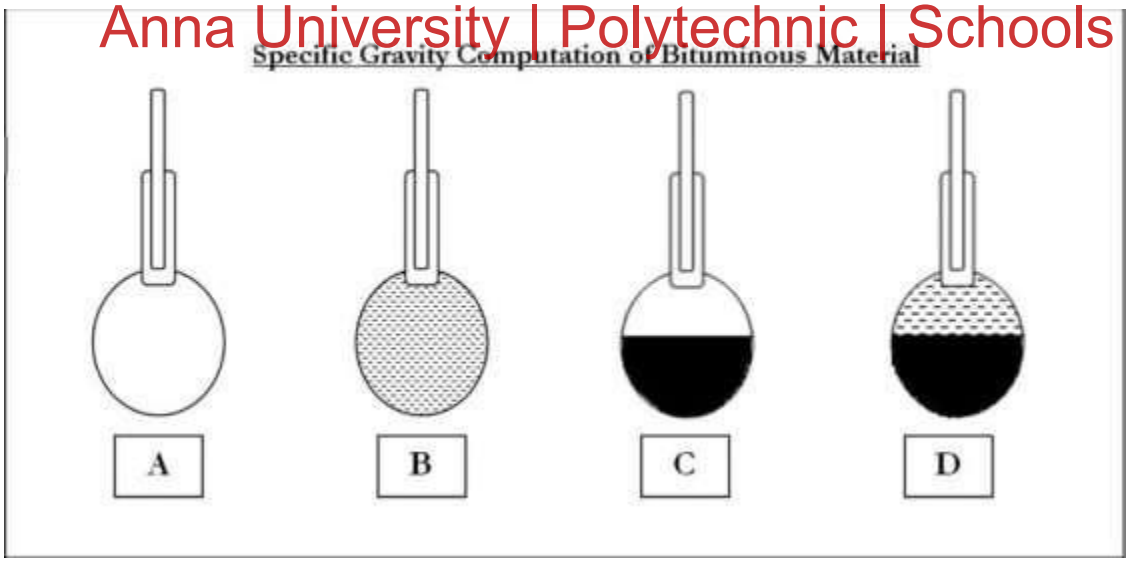
Weight of water absorbed $W = W_2 - W_1$ =

Percentage of water absorption $\frac{(W_2 - W_1)}{W_1} \times 100$ =

The Indian Standard (IS) code for the water absorption test for coarse aggregates is IS 2386-3:1963. The maximum water absorption of coarse aggregates as per IS code is 2% by weight.

Result:

Water absorption of the coarse aggregate is _____



		TRIAL 1	TRIAL 2
Mass of Pycnometer plus Stopper	W_1		
Mass of Pycnometer filled with water	W_2		
Mass of Pycnometer partially filled with Bitumen	W_3		
Mass of Pycnometer plus Bitumen plus Water	W_4		
Specific gravity of bituminous material = $\frac{(W3-W1)}{(W2-W1)-(W4-W3)}$			
Mean Specific Gravity			

EX.NO:4	Specific Gravity Determination of The Bitumen/Asphalt Sample
DATE:	

AIM

To determine the specific gravity of given Bituminous material.

APPARATUS REQUIRED:

Specific gravity bottle, balance and distilled water.

PROCEDURE:

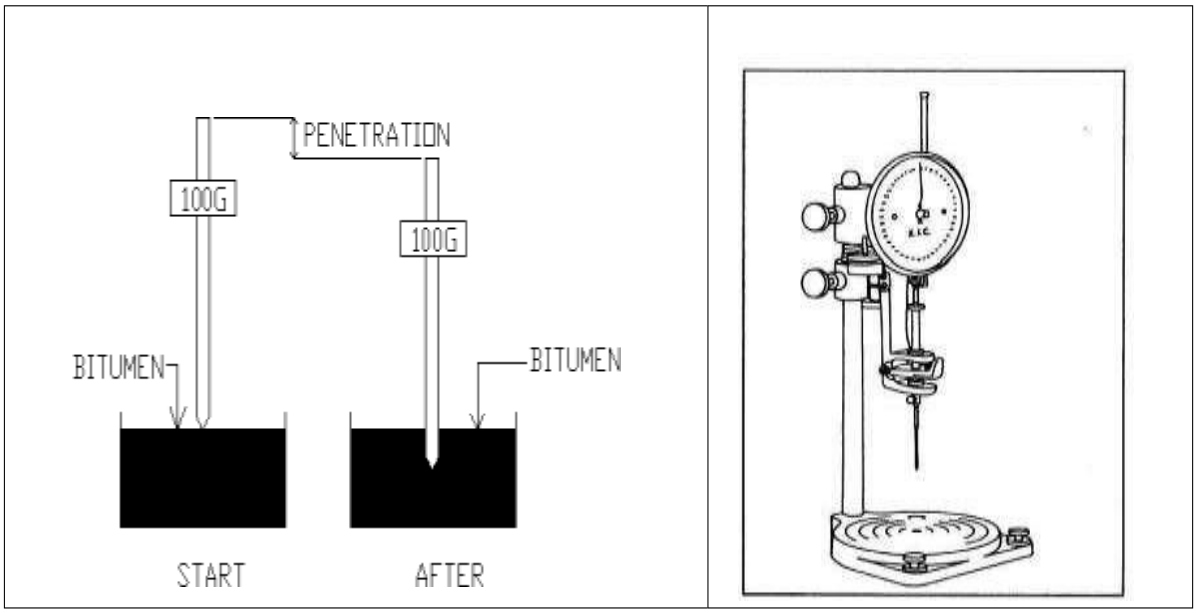
1. The clean, dried specific gravity bottle is weighed let that be W1 gm
2. Than it is filled with fresh distilled water and then kept in water bath for at least half an hour at temperature 27°C±0.1°C.
3. The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. Let this be W_2 gm.
4. Then the specific gravity bottle is emptied and cleaned. The bituminous material is heated to a pouring temperature and the material is poured half the bottle, by taking care to prevent entry of air bubbles. Then it is weighed. Let this be W_3 gm.
5. The remaining space in specific gravity bottle is filled with distilled water at 27°C and is Weighed. Let this be W_4 gm.

The Indian Standard (IS) code for the specific gravity test of bitumen is IS 1206-1984. The permissible range of specific gravity of bitumen as per IS code is 0.97 to 1.02.

RESULT:

The specific gravity of given bituminous binder is_____

Penetration Test of Bitumen



Observations for Penetration Test

Actual test temperature = °C

Penetration Dial Reading	Trial 1	Trial 2	Trial 3
(a) Initial			
(b) Final			
Penetration value			
Mean Value			

EX.NO:5	Determination of Consistency of The Bituminous Material
DATE:	

AIM:

To determine the consistency of bituminous material

APPARATUS REQUIRED:

Penetrometer, Thermometer, Time measuring device, Transfer dish, Water bath, Needle, Container with a flat bottomed cylindrical metallic dish of diameter 55mm and depth 35mm is required.

PROCEDURE:

1. Soften the material to a pouring consistency at a temperature not more than 60°C for tars and 90°C for bitumen above the approximate softening point and stir it thoroughly until it is homogenous and is free from air bubbles and water. Pour the melt into the container to a depth atleast10mm in excess of the expected penetration. Protect the sample from dust and allow it to cool in an atmosphere at a temperature between 15° to 30°C for one hour. Then place it along with the transfer dish in the water bath at 25.0° ±0.1°C and allow it to remain for 1 to 11/2 hour. The test is carried out at 25.0° ±0.1°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 stand of the penetration apparatus.
3. Clean the needle with benzene, dry it and load with weight. The total moving load required is 100±0.25gms, including the weight of the needle, carrier and super-imposed weights
4. Adjust the needle to make contact with the surface of the sample. This may be done by placing the needle point 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 five seconds
7. Adjust the penetration machine to measure the distance penetrated.
8. Make at least 3 reading 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 and wash the needle clean with benzene and dry it. In case of material of penetration

greater than 225 three determinations on each of the two identical tests specimens using a separate needle for each determination should be made, leaving the needle in the sample on completion of each determinations to avoid disturbance of the specimen.

The Indian Standard (IS) code for bituminous materials is IS 10775:2013. The following are the limitations of consistency of bituminous materials as per this code:

- **Penetration :** The penetration of bitumen is the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in 5 seconds under specified temperature, load and duration of loading. The limitation of penetration for bituminous materials is 60 to 200.
- **Softening point :** The softening point of bitumen is the temperature at which it softens to such an extent that a standard needle can pierce it. The limitation of softening point for bituminous materials is 50 to 70 degrees Celsius.
- **Ductility :** The ductility of bitumen is the measure of its ability to be stretched without breaking. The limitation of ductility for bituminous materials is 150 to 200 millimeters.
- The following table summarizes the limitations of consistency of bituminous materials as per IS 10775:2013:

Consistency test	Limitation
Penetration	60 to 200
Softening point	50 to 70 degrees Celsius
Ductility	150 to 200 millimeters

RESULT:

The Penetration value of given bitumen is_____**mm.**

The following table summarizes the limitations of viscosity of bituminous binders in seconds as per IS 73:2013:

Viscosity test	**Limitation (seconds)**
Viscosity at 60°C (Saybolt Furol)	170 to 300
Viscosity at 135°C (Saybolt Universal)	1.8 to 3.5

EX.NO:6	Viscosity Determination of Bituminous Binder
DATE:	

AIM:

To determine the viscosity of bituminous binder.

APPARATUS REQUIRED:

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.

PROCEDURE:

1. The tar cup is properly levelled and water in the bath is heated to the test temperature.
2. Material is heated to 20°C above the test temperature and material is allowed to cool. Duringthis material is continuously stirred.
3. When the temperature reaches 40°C, it is poured into cup of the Tar Viscometer untilleveling peg on valve rod is immersed.
4. Receiver is placed under the orifice.
5. Valve is opened after applying kerosene in the receiver.
6. Stop watch is started when cylinder records 50ml time is recorded for flow upto a mark of100ml.
7. The time in seconds for 50ml of the test sample to flow through the orifice is the viscosity ofthe sample at the given test temperature.

RECORD AND OBSERVATION:

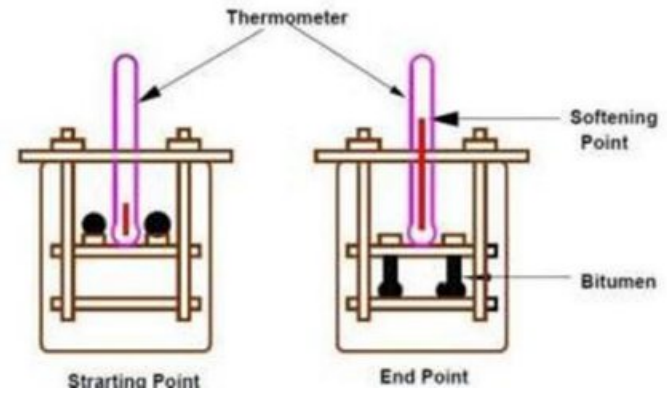
Specification	Test 1	Test 2
Test temperature		
Time taken to flow 50ml of binder		
Viscosity	***Seconds***	***Seconds***

RESULT:

The Viscosity value of given bitumen is_____**Seconds.**

Softening Point Test

Specification	1	2	Average softening point of bitumen
Temperature when the ball touches bottom ^oC			



EX.NO:7	Determination of Softening Point of The Asphalt/Bitumen Sample
DATE:	

AIM:

To determine the softening point of bitumen

APPARATUS REQUIRED:

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

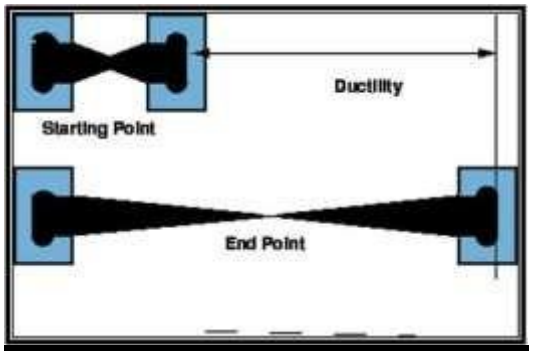
PROCEDURE.

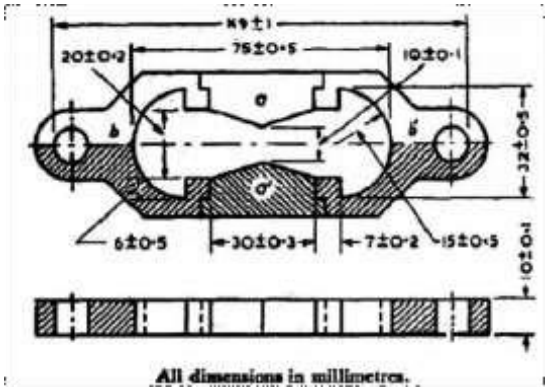
1. Heat the material to a temperature between 75^{o} – 100^{o}C above its softening point, stir until, it is completely fluid and free from air bubbles and water. If necessary filter it through IS sieve 30.
2. Place the rings, previously heated to a temperature approximating to that of the molten material. On a metal plate which has been coated with a mixture of equal parts of glycerin and dextrin. After cooling for 30 minutes in air, level the material in the ring by removing the excess with a warmed, sharp edged knife.
3. Assemble the apparatus with the rings, thermometer and ball guides in position.
4. Fill the bath with distilled water to a height of 50mm above the upper surface of the rings. The starting temperature should be5^{o}C.
5. Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5±0.5^{o}C per minute.
6. Note down the temperature when any of the steel ball with bituminous coating touches the bottom plate.

RESULT

The Softening Point of the given bituminous material is =

Ductility Value of The Bitumen





EX.NO:8	Determination of Ductility Value of The Bitumen Sample
DATE:	

AIM:

1. To measure the ductility of a given sample of bitumen
2. To determine the suitability of bitumen for its use in road construction

APPARATUS REQUIRED:

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

PROCEDURE

1. Melt the bituminous test material completely at a temperature of 75°C to 100°C above the approximate softening point until it becomes thoroughly fluid.
2. Strain the fluid through IS sieve 30.
3. After stirring the fluid pour it in the mould assembly and lace it on the brass plate.
4. In order to prevent the material under test from sticking, coat the surface of the plate and interior surface of the sides of the mould with mercury or by a mixture of equal parts of glycerin and dextrin.
5. After about 30 – 40 minutes, keep the plate assembly along with the sample in a water bath. Maintain the temperature of the water bath at 27°C for half an hour.
6. Remove the sample and mould assembly from the water bath and trim the specimen by leveling the surface using a hot knife.
7. Remove the sides of the moulds.
8. Hook the clips carefully on the machine without causing any initial strain.
9. Adjust the pointer to read zero.
10. Start the machine and pull two clips horizontally at a speed of 50mm per minute.

14. Note the distance at which the bitumen thread of specimen breaks.

12. Record the observations in the Performa and compute the ductility value report the mean of two observations, rounded to nearest whole number as the "Ductility Value".

RECORD AND OBSERVATION

I	Bitumen grade	=	
II	Pouring temperature ^{o}C	=	
III	Test temperature ^{o}C	=	
IV	Periods of cooling, minutes	=	

RESULT:

The Ductility value of given bitumen is_____**mm.**

Observation Table:

(A sample observation table for loss on heating test of bitumen is drawn below)

Descriptions	Sample – 1	Sample – 1
Initial Weight of Sample in gm (W1)		
Final Weight of Sample in gm (W2)		
Loss on Heating (W1 – W2) in gm		
Penetration Value before testing P1 (in mm)		
Penetration Value after testing P2 (in mm)		
Reduction in Penetration Value P1 – P2 (in mm)		

(Note: Penetration values are to be noted ONLY when hardening is to be measured along with loss on heating test of bitumen)

Loss in weight on heating = Average value of loss obtained for specimens 1 and 2.

Apply corrections for water loss, if the water is present in the natural conditions of the sample. Water content is determined and is added to the final result.

EX.NO:9	Estimation Of Loss of Bitumen On Heating
DATE:	

AIM:

To determine the loss of volatiles present in asphaltic bitumen on heating.

SIGNIFICANCE:

Bitumen is commonly used as a binder in pavements. When it is exposed to the atmosphere, the volatiles present in it evaporates and bitumen hardens.

In the loss of heating of bitumen, the bitumen specimen is subjected to an accelerated ageing process under the conditions specified by the standard.

By carrying out penetration test at the start and finish of the test, the amount by which bitumen hardens can be known.

IMPORTANT TERMS:

Loss on Heating: The loss of volatiles like oil except water on heating the bituminous material to standard temperature and under predetermined conditions is termed as a loss on heating.

PRINCIPLE:

The practical works on the below principle:

The volatile materials evaporate when they are subjected to high temperatures. Bitumen is heated to about 163 ° C so that the volatile materials are evaporated.

APPARATUS FOR LOSS OF HEATING OF BITUMEN TEST:

The apparatus used while conducting loss on heating test of bitumen is described below:

1. Hot Air Oven:

2. Perforated Metal Shelf
3. Container
4. Thermometer or Temperature Indicator and Controller
5. Weighing Balance
6. Asbestos gloves
7. Penetrometer and water bath
8. Container to mix bitumen of about 225 gram
9. Hotplate

PRECAUTION:

The following precautions should be taken while performing the loss on a heating test of bitumen to obtain accurate results:

- The loss on a heating test of bitumen should be conducted in duplicate
- If there is presence of water in the sample, it should be tested in that composition only
- The temperature of the oven should be strictly maintained to 163 °C
- Hot air oven, analytical balance, penetrometer and water bath should be calibrated in a while
- Water content of the sample should be determined in accordance with IS 1211: 1978 as the method of determination of water content specified
- If the sample shows evidence of loss by foaming, that sample should not be considered but rejected

PROCEDURE FOR LOSS ON HEATING TEST OF BITUMEN:

1. Agitate the bituminous material by stirring as received so that a complete mixture is obtained. Heat the sample above its softening point, if necessary.
2. Heat the containers at 100-110 °C for about 30 minutes in the oven and then allow them to cool at room temperature and measure the weight of the empty containers.
3. Take a portion of the well-mixed material for testing in a container and allow it to cool. Prepare at least 2 such specimens.

4. Weigh the sample along with the container to the nearest 0.1 gram and subtract the weight of the container to obtain the weight of the sample- W1. The weight of the sample filled in the container is 50.0 ± 0.5 grams.
5. If penetration values are to be compared too, then pour the sample in the penetrometer cup also. Find out the penetration value as specified in IS: 1203-1978.
6. Set the temperature of the oven to 163 ± 1 °C.
7. Place the container with the sample on the perforated shelf placed centrally and close the oven.
8. Maintain the temperature to 163 ± 1 °C for 5 hours after the oven has achieved the specified temperature. The duration for which the sample is placed in the oven should not be more than 5 hours and 15 minutes.
9. Switch on the motor switch to allow the perforated plate to rotate at a rate of 5-6 rev/min.
10. Allow the sample in the containers to cool at room temperature.
11. Weight the sample to the nearest 0.1 gram- W2.
12. Determine the water content for the sample as done in the determination of water content test in accordance with IS: 1211- 1978.
13. Calculate the weight loss of volatile materials because of heating from the above-observed values.
14. Arrange the containers on the perforated shelf and turn on the oven for 5 minutes at the specified temperature.
15. If the penetration test is also to be compared, then mix the sample of the containers and keep the mixture on a hotplate so that it remains in the liquid state. Pour the mixture into a penetrometer cup and determine the penetration value. The value will be less than the previous one.

RESULT:

The values obtained from the loss on heating test of bitumen are recorded as follows:

Loss in Weight (in gram)	The average loss of weight of the two containers
Loss in weight after the test (in %)	=(Average Weight Loss/ Original Average Weight of Sample) x 100
Reduction in penetration value (in %)	= (Reduction in Penetration Value / Original Penetration Value of Sample) x 100

EX.NO:10	Determination of Optimum Binder Content By Marshall Method
DATE:	

AIM

To determine the Marshall Stability and Flow Values of a given bituminous material.

MATERIALS REQUIRED

Breaking Head

Loading Jack

Ring Dynamometer Assembly or Electronic Equivalent Flow meter

Water Bath Air Bath

PROCEDURE

1. Equipment Preparation

Thoroughly clean the guide rods and the inside surfaces of the test heads prior to making the test, and lubricate the guide rods so that the upper test head slides freely over them.

2. Sample Preparation

Samples will be prepared in accordance with STP 204-8, Preparation of Marshall Compaction Specimens or collected in accordance with STP 204-5, Asphalt Concrete Samples Obtained by Coring.

3. Test Procedure

1. Bring the specimens prepared with asphalt cement to the specified temperature by immersing in a water bath 30 minutes. Maintain the bath or oven temperature at 60 ± 1o C for asphalt cement specimens. Bring the specimens prepared with asphalt cutback to the specified temperature by placing them in the air bath for a minimum of 2 hours. Maintain the air bath temperature at 25 ± 1o C.
2. The testing head temperature shall be maintained between 20 to 38° C. Remove the specimen from the water bath, oven or air bath and place in the lower segment at the breaking head. Place the upper segment of the breaking head on the specimen and place the complete assembly in position on the testing machine.
3. Place the flow meter, where used, in position over one of the guide rods and adjust the flow meter to zero while holding the sleeve firmly against the upper segment of the breaking head. Hold the flow meter sleeve firmly against the upper segment of the breaking head while the test load is being applied.
4. Apply the load to the specimen by means of the constant rate of movement of

the load jack or testing machine head of 50.8 mm/minute until the maximum load is reached and the load decreases as indicated by the dial.

5. Record the maximum load noted on the testing machine or converted from the maximum micrometer dial reading. Release the flow meter sleeve or note the micrometer dial reading, where used, the instant the maximum load begins to decrease.
6. Note and record the indicated flow value or equivalent units in mm if a micrometer dial is used to measure the flow. The elapsed time for the test from removal of the test specimen from the water bath to the maximum load determinations shall not exceed 30 seconds.

RESULTS & CALCULATIONS

Collection of Test Results

For specimens other than 63.5 mm in thickness correct the load by using the proper multiplyingfactor from Table 1.

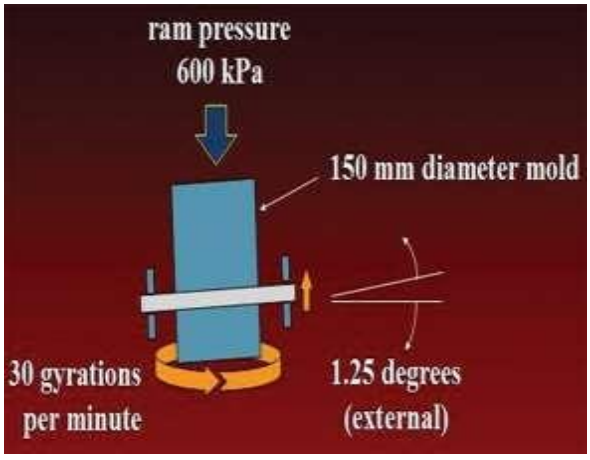
The reports shall include the following information:

a) Type of sample tested (lab sample or pavement core specimen). For core specimens the height of each test specimen in mm shall be reported.

b) Average maximum load in newtons, corrected when required.

c) Average flow value in millimetres.

d) Test temperature



Marshal Stability Test Setup

TABLE 1 Stability Correlation Ratios*

Volume of Specimen (cm^3)	Thickness of the Specimen (mm)	Correlation Ratio
200 to 213	25.4	5.56
214 to 225	27.0	5.00
225 to 237	28.6	4.55
238 to 250	30.2	4.17
251 to 264	31.8	3.85
265 to 276	33.3	3.57
277 to 289	34.9	3.33
290 to 301	36.5	3.03
302 to 316	38.1	2.78
317 to 328	39.7	2.50
329 to 340	41.3	2.27
341 to 353	42.9	2.08
354 to 367	44.4	1.92
368 to 379	46.0	1.79
380 to 392	47.6	1.67
393 to 405	49.2	1.56
406 to 420	50.8	1.47
421 to 431	52.4	1.39
432 to 443	54.0	1.32
444 to 456	55.6	1.25
457 to 470	57.2	1.19
471 to 482	58.7	1.14
483 to 495	60.3	1.09

496 to 508	61.9	1.04
509 to 522	63.5	1.00
523 to 535	64.0	0.96
536 to 546	65.1	0.93
547 to 559	66.7	0.89
560 to 573	68.3	0.86
574 to 585	71.4	0.83
586 to 598	73.0	0.81
599 to 610	74.6	0.78
611 to 625	76.2	0.76

*** The measured stability of a specimen multiplied by the ratio for the thickness of the specimen equals the corrected stability for a 63.5 mm specimen**

The Indian Standard (IS) code for Marshall mix design is IS 1892-2013. The following are the specifications for Marshall mix design as per IS 1892-2013:

- The Marshall specimen should be 102 mm (4 inch) in diameter and 63.5 mm (2.5 inch) in height.
- The specimen should be compacted in a Marshall hammer with 50 blows on each end.
- The Marshall stability is the load required to break the specimen in half. The minimum Marshall stability requirement is 340 kg for bituminous mixtures subjected to light traffic and 910 kg for bituminous mixtures subjected to heavy traffic.
- The flow is the distance that the top half of the specimen moves when it is subjected to a load. The maximum flow requirement is 17 mm for

bituminous mixtures subjected to light traffic and 12 mm for bituminous mixtures subjected to heavy traffic.

- The air voids in the mixture should be in the range of 3 to 5% for bituminous mixtures subjected to light traffic and 4 to 6% for bituminous mixtures subjected to heavy traffic.
- The voids filled with bitumen should be in the range of 75 to 85% for bituminous mixtures subjected to light traffic and 70 to 80% for bituminous mixtures subjected to heavy traffic.

Result

Test Property	Specified Value
Marshall stability, kg	
Flow value, 0.25 mm units	
Percent air voids in the mix V_v %	
Voids filled with bitumen VFB%	

EX.NO:11	Determination of Stripping Value of The Bituminous Mix
DATE:	Demonstration

Aim:

To determine the stripping value of road aggregates by binders.

Apparatus Requires for Test:

The apparatus required for this experiment are:

1. Thermostatically controlled water bath.
2. Oven to heat aggregate.
3. Sieves of sizes 20 mm and 12.5 mm.
4. Beaker of 500 ml capacity.
5. Mixer to mix aggregate and bitumen.

Procedure:

1. 200 g of clean and dry aggregate passing 20 mm IS sieve and retained on 12.5 mm sieve are heated up to 150°C when these are to be mixed with bitumen.
2. Bitumen binder amounting to five percent by weight of aggregate is heated to 160°C.
3. The aggregate and binder are mixed thoroughly till they are completely coated and mixture is transferred to the beaker and allowed to cool at room temperature for about 2 hours.
4. Distilled water is then added to immerse the coated aggregates.
5. The beaker is covered and kept in a water bath maintained at 40°C, for 24 hours.
6. After 24 hours, the beaker is taken out, cooled at room temperature and the extent of stripping is estimated visually while the specimen is still under water.

Result:

The result is reported as the percentage of stone surface that remains coated after the specified periods, the mean value of at least three visually estimated values, being rounded off to the nearest 5 percent.

By visual estimation, stripping value of road aggregates is =%

EX.NO: 12	Determination of Bitumen Content In The Bituminous Mix By Cold Solvent Extraction Method
DATE:	

Aim

To determine the binder content (bitumen) in the asphalt mix by cold solvent extraction method.

Code References

1. IRC: SP 11 –1988 (Appendix - 5)
2. ASTM D 2172

Apparatus Required

1. Centrifuge
2. Balance of capacity 500 grams and sensitivity 0.01grams.
3. Thermostatically controlled oven with capacity up to 2500 C.
4. Beaker for collecting extracted material.

Fig 1: Centrifuge for Bitumen Extraction Test

Procedure of Test

1. Take exactly 500 grams of the representative sample and place it in the bowl of the extraction apparatus (W1).
2. Add benzene to the sample until it is completely submerged.

3. Dry and weigh the filter paper and place it over the bowl of the extraction apparatus containing the sample (B).
4. Clamp the cover of the bowl tightly.
5. Place a beaker under the drainpipe to collect the extract.
6. Sufficient time (not more than an hour) is allowed for the solvent to disintegrate the sample before running the centrifuge.
7. Run the centrifuge slowly and then gradually increase the speed to a maximum of 3600 rpm.
8. Maintain the same speed till the solvent ceases to flow from the drainpipe.
9. Run the centrifuge until the bitumen and benzene are drained out completely.
10. Stop the machine, remove the cover and add 200ml of benzene to the material in the extraction bowl and the extraction is done in the same process as described above.
11. Repeat the same process not less than three times till the extraction is clear and not darker than a light straw color.
12. Collect the material from the bowl of the extraction machine along with the filter paper and dry it to constant weight in the oven at a temperature of 1050 C to 1100 C and cool to room temperature.
13. Weigh the material (W2) and the filter paper (D) separately to an accuracy of 0.01grams.

Calculation and Observation

Sl No	Observation	Sample 1	Sample 2	Sample 3
1	Weight of mix taken before extraction (W1)			
2	Weight of filter paper before extraction (B)			
3	Weight of mix after extraction (W2)			
4	Weight of filter paper after extraction (D)			
5	Weight of filler collected in filter paper (B-D) =W3			

The formula to calculate the percentage of binder content is given by-

$$= \frac{W1 - (W2 + W3)}{W1} X\ 100$$

Result

The average percentage of Binder content in the given Bitumen Mix = _____%

The result obtained shall be reported as the percentage of binder content in the mix to the nearest second decimal.

Annexture

What are the Types of VG Bitumen

As per IS:73-2006 , bitumen is classified into four types based on viscosity, as given below.

- VG-10
- VG-20
- VG-30
- VG-40

What are the Requirements of Paving Bitumen (VG Bitumen)

Characteristics	Paving Grades or Viscosity Grade Bitumen Requirements			
	VG-10	VG-20	VG-30	VG-40
Absolute viscosity at 60^0C, Poises, Min	800	1600	2400	3200
Kinematic viscosity at 135^0C, cSt, Min	250	300	350	400
Flash point, (cleveland open cup), ^{0}C, Min	220	220	220	220
Solubility in trichloroethylene, %, min	99.0	99.0	99.0	99.0
Penetration at 25^0C	80-100	60-80	50-70	40-60
Softening point, ^{0}C, Min	40	45	47	50
Tests on residue from				

thin film oven test/RTFOT				
1. Viscosity ratio at 60^{0}C, Max	4.0	4.0	4.0	4.0
2. Ductility at 25^{0}C, cm, Min, after thin film oven test	75	50	40	25

https://civilblog.org/2014/11/25/viscosity-grade-bitumen-what-are-the-types-and-their-specifications/

List of IS Codes Related to Bitumen Testing

Tests for Bitumen with IS codes	
Name of Test	**IS code Number**
Penetration Test	IS: 1203-1978
Ductility test	IS: 1208-1978
Softening Point test	IS: 1205-1978
Specific gravity test	IS: 1202-1978
Viscosity test	IS: 1206-1978
Flash and Fire Point test	IS: 1209-1978

Float Test	IS: 1210-1978
Determination of Water Content	IS: 1211-1978
Determination of Loss on Heating	IS:1212-1978

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Lab Tests on Bitumen to Check Quality

Various tests are conducted on bitumen to assess its consistency, gradation, viscosity, temperature susceptibility, and safety.

There are a number of tests to assess the properties of bituminous materials. The following tests are usually conducted to evaluate different properties of bituminous materials.

1. Penetration test
2. Ductility test
3. Softening point test
4. Specific gravity test
5. Viscosity test
6. Flash and Fire point test
7. Float test
8. Water content test
9. Loss on heating test

https://civilblog.org/2015/09/11/9-test-to-check-quality-of-bitumen-for-use-in-road-work/

DIFFERENCES BETWEEN BITUMEN AND TAR USED IN ROAD CONSTRUCTION

The following are the differences between bitumens and tars.

1. The weathering properties of bitumens are superior to those of tars. Generally greater deterioration is produced in tar than in bitumen when exposed to equal weather conditions. Bitumens have a better durability and resistance to weathering than tars.
2. Tars are more susceptible to temperature changes than bitumens. Hot weather will soften a tar surface more than a surface made with bitumen of the same viscosity, and it will become more brittle at low temperatures than bitumen. In other words tar becomes brittle in cold weather and the surface treated with tar is apt to bleed in hot weather if a little extra quantity has been used. Tar is therefore considered unsuitable for locations with wide temperature changes. Gritting or surface dressing can be delayed a little where bitumen has been used but not with tar.
3. Surface dressings with bitumen are more prone to failure by water displacement than those made with tar. Tars generally adhere better than bitumens on wet aggregate.
4. Tars can be brought to a spraying condition at lower temperatures than those needed for bitumens; stones need not be heated to high temperatures.
5. Setting time for tars is more than that of bitumens and this property is useful in the production of pre-coated aggregate which can be transported to large distances or kept for sometime before spreading.
6. Tars harden much quicker than bitumens.
7. Tars have higher specific gravity than bitumens and lower viscosity and these properties give them greater penetrating power and which are more marked during summers. Higher viscosities can generally be used with tars than with bitumens.
8. Tars produce a less slippery surface than bitumens.
9. Bitumens have a tendency to stay at or just near the surface resulting in a rich and fat surface.
10. Roads built of bitumen need constant traffic to be maintained in good order; otherwise the surface will crack and reduce the life of the road.
11. Tars make harder surfaces (but such surfaces are brittle) than bitumens and should be preferred for roads in areas where bullock carts or other hard tyred

traffic predominates. Bitumens make more elastic surfaces and are better suited for pneumatic traffic. Hardening of bitumens is very gradual.

12. Tar is more suitable for dense fine grained surfaces and bitumen for more open surfaces.
13. Volume of tar required is about 10 percent less than that of bitumen for the same type of road work.
14. Tar is cheaper than bitumen.
15. A primer is not generally needed with tar.
16. Road tars do not dissolve in a petroleum distillate such as petrol, kerosene, diesel oil. As such tar carpets have proved to be good material for parking sites as it remains unaffected by spillage of oil and petrol from automobiles.

https://civilblog.org/2015/07/15/15-differences-between-bitumen-and-tar-used-in-road-construction/

List of IS Codes Related to Aggregate Testing

Tests for Aggregates with IS codes		
Property of Aggregate	**Type of Test**	**Test Method**
Crushing strength	Crushing test	IS : 2386 (part 4)
Hardness	Los Angeles abrasion test	IS : 2386 (Part 5)
Toughness	Aggregate impact test	IS : 2386 (Part 4)
Durability	Soundness test	IS : 2386 (Part 5)
Shape factors	Shape test	IS : 2386 (Part 1)
Specific gravity and porosity	Specific gravity test and water absorption test	IS : 2386 (Part 3)

Adhesion to bitumen	Stripping value of aggregate	IS : 6241-1971

Previous Year University Lab Question

B.E / B.Tech. PRACTICAL END SEMESTER EXAMINATIONS

Sixth Semester

CE8611 - HIGHWAY ENGINEERING LABORATORY

(Regulations 2017)

Time : 3 Hours Answer any one Question Max. Marks 100

(To be filled by the question paper setter)

Aim/Principle/ Apparatus required/ Procedure	Tabulation/Circuit /Program/Drawing	Calculation & Results	Viva-Voce	Record	Total
30	20	30	10	10	100

1.	Determine the Specific Gravity of the Given Fine Aggregate Sample.
2.	Determine the Specific Gravity of the Given Coarse Aggregate Sample.
3.	Determine the Abrasion test of the Given Sample.
4.	Determine the Specific Gravity of the Given Bitumen Sample.
5.	Determination the Penetration Value of the Given Bitumen Sample.
6.	Determination the Viscosity of the Given Bitumen Sample.
7.	Determination the Softening Point of the Given Bitumen Sample.
8.	Determination the Ductility of the Given Bitumen Sample.
9.	Determination the Binder content by Centrifuge Extractor of the Given Bitumen Sample.
10.	Determine optimum Binder content of given bituminous mix by Marshall Method of mix design.

11.	Determine the Stripping test of the Given Bitumen Sample.
12.	Determine the Water Absorption of the Given Aggregate Sample.
13.	Determine the Softening Point of the Given VG-40 Bitumen Sample.
14.	Determine the Penetration Value of the Given Bitumen 30/40 Sample.
15.	Determine the Ductility of the Given VG-30 Bitumen Sample.
16.	Determine the Penetration Value of the Given Bitumen 40/50 Sample.
17.	Determine the Ductility of the Given VG-40 Bitumen Sample.
18.	Determine the Binder content of Bituminous Mix.
19.	Determining the flow value of the Bituminous Mixture.
20.	Determination the Viscosity of the Given VG-20 Bitumen Sample.