Varuvan Vadivelan Institute of Technology

Dharmapuri – 636 703

LAB MANUAL

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CE6612-CONCRETE AND HIGHWAY ENGINEERING LAB

ANNA UNIVERSITY CHENNAI

REGULATION -2013

CE6612-CONCRETE AND HIGHWAY ENGINEERING LABORATORY

LIST OF EXPERIMENTS

TEST ON FRESH CONCRETE

1. SLUMP CONE TEST
2. FLOW TABLE
3. COMPACTION FACTOR
4. VEE BEE TEST

TEST ON HARDENED CONCRETE

1. COMPRESSIVE STRENGTH – CUBE & CYLINDER
2. FLEXTURE TEST
3. MODULUS OF ELASTICS

TEST ON BITUMEN

1. PENETRATION
2. SOFTENING POINT
3. DUCTILITY
4. VISCOSITY
5. ELASTIC RECOVERY
6. STORAGE STABILITY

TEST ON AGGREGATES

1. STRIPPING
2. SOUNDNESS
3. PROPORTIONING OF AGGREGATES
4. WATER ABSORPTION

TESTS ON BITUMINOUS MIXES

1. DETERMINATION OF BINDER CONTENT
2. MARSHALL STABILITY AND FLOW VALUES
3. SPECIFIC GRAVITY
4. DENSITY

TOTAL HOURS =60 HOURS

INDEX

EX.NO	DATE	NAME OF THE EXPERIMENT	STAFF SIGNATURE	REMARKS
		TESTS ON CONCRETE		
1		Determine the Workability of Concrete using Slump cone Apparatus		
2		Determine the Workability of Concrete using Flow Table Apparatus		
2		Determine the Workability of Concrete using Compaction Factor Apparatus		
4		Determine the Workability of Concrete using Vee Bee Consistometer Apparatus		
5		Determine the Compressive Strength on concrete by using (a) Cube (b) cylinder		
6		Determine the Flexural Strength on Concrete		
		TESTS ON AGGREGATE		
7		Elongation index of Aggregate		
8		Flakiness index of aggregate		
9		Impact test		
10		Abrasion test		
11		Water absorption test		

TESTS ON BITUMEN				
EX.NO	**DATE**	**NAME OF THE EXPERIMENT**	**STAFF SIGNATURE**	**REMARKS**
12		Flash and Fire point test		
13		Determine the test on Specific Gravity		
14		Determination of penetration value		
15		Determination of softening point test		
16		Determination of ductility of bitumen		
17		Determination of viscosity		
18		Determination of bitumen by centrifuge extractor		
19		Determination of bitumen by marshall method		

INTRODUCTION

CONCRETE:

Concrete is a composite material which is made up of a filler and a binder. Typical concrete is a mixture of fine aggregate (sand), coarse aggregate (rock), cement, and water.

Under no circumstances should the word "cement" be used to refer to the composite product "concrete".

Portland cement, so named for its color similarity with limestone near Portland England, is composed primarily of four complex compounds: tricalcium silicate, declaim silicate, tricalcium aluminate, and tetracalcium aluminoferrite.

WATER

Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes the hardening of concrete through a process called hydration. Hydration is a chemical reaction in which the major compounds in cement form chemical bonds with water molecules and become hydrates or hydration products. Details of the hydration process are explored in the next section. The water needs to be pure, typically drinkable, in order to prevent side reactions from occurring which may weaken the concrete or otherwise interfere with the hydration process.

The role of water is important because the water to cement ratio is the most critical factor in the production of "perfect" concrete. Too much water reduces concrete strength, while too little will make the concrete unworkable. Concrete needs to be workable so that it may be consolidated and shaped into different forms (i.e.. walls, domes, etc.). Because concrete must be both strong and workable, a careful balance of the cement to water ratio is required when making concrete.

AGGREGATES

Aggregates are chemically inert, solid bodies held together by the cement. Aggregates come in various shapes, sizes, and materials ranging from fine particles of sand to large, coarse rocks. Because cement is the most expensive ingredient in making concrete, it is desirable to minimize the amount of cement used. 70 to 80% of the volume of concrete is aggregate in order to keep the cost of the concrete low. The selection of an aggregate is determined, in part, by the desired characteristics of the concrete. For example, the density of concrete is determined by the density of the aggregate. Soft, porous aggregates can result in weak concrete with low wear resistance, while using hard aggregates can make strong concrete with a high resistance to abrasion.

PROPERTIES OF CONCRETE

Concrete has many properties that make it a popular construction material. The correct proportion of ingredients, placement, and curing are needed in order for these properties to be optimal.

- Water-cement ratio is by far the most important factor.
- The age of the cured concrete is also important. Concrete gradually builds strength after mixing due to the chemical interaction between the cement and the water. It is normally tested for its 28 day strength, but the strength of the concrete may continue to increase for a year after mixing.
- Character of the cement, curing conditions, moisture, and temperature. The greater the period of moist storage (100% humidity) and the higher the temperature, the greater the strength at any given age.
- Air entrainment, the introduction of very small air voids into the concrete mix, serves to greatly increase the final product's resistance to cracking from freezing-thawing cycles. Most outdoor structures today employ this technique.

HIGHWAY MATERIALS

- Soil Definition (Engineering)
  - “refers to all unconsolidated material in the earth’s crust, all material above the bedrock”
    - mineral particles (gravel, sand, silt, clay)
    - organic material (top soil, marshes)

- Aggregates
  - mineral particles of a soil
  - specifically, granular soil group
    - gravel, sand, silt
- Granular Soil Group (Aggregates)
  - Physical weathering
    - action of frost, water, wind, glaciers, plant/animals
    - particles transported by wind, water, ice

- soils formed are called granular soil type
- "grains are similar to the original bedrock"

– Larger grain sizes than clays

– Particles tend to be more or less spheres/cubes

– Bound water is small compared to overall mass

- Crushed Rock
  - – Metamorphic Rocks
  - – Igneous or Sedimentary rocks that have been metamorphosed due to intense heat and pressure
    - Slate shale
    - Marble limestone
    - Quartzite sandstone
    - Gneiss granite

EX NO:1

DATE:

SLUMP CONE TEST

AIM:

To measure the consistency of concrete by using slump cone

APPARATUS REQUIRED:

Slump cone, tamping rod, metallic sheet.

PROCEDURE.

1. The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing test.
2. The mould is placed on a smooth, horizontal rigid and non – absorbent surface.
3. The mould is then filled in four layers each **approximately 1/4** of the height of the mould.
4. Each layer is tamped **25 times** rod taking care to distribute the strokes evenly over the cross section. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod.
5. The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction.
6. This allows the concrete to subside. This subside is referred as slump of concrete.
7. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete.
8. The pattern of slump indicates the characteristics of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one of the cone slides down ,it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence .

RESULT:

The slump value of concrete is _____________**mm**

EX NO : 2
DATE :

FLOW TABLE TEST

AIM:

To measure the flow and workability of the concrete by using flow table

APPARATUS REQUIRED:

Flow table test apparatus

PROCEDURE:

1. The table top is cleaned of all gritty material and is wetted. The mould is kept on the centre of the table, firmly held and is filed in to layers.

2. Each layer is **rodded 25 times** with a **tamping rod 1.6 cm in diameter and 61** cm long rounded at the lower tamping end.

3. After the top layer is rodded even the excess of concrete which has overflowed the mould is removed.

4. The mould is lifted vertically upward and concrete stands on its own without support. The table is then raised and dropped **12.5 cm 15 times in about 15 seconds.**

5. The diameter of the spread concrete is measured in about **6 directions** to the nearest **5 mm** and the average spread is noted .The flow of concrete is % increase in the average diameter of the spread concrete over the base diameter of the mould.

6. The value could range anything from **0 to 150 percent** .A close look at pattern of spread of concrete can also give a good indication of the characteristics of concrete such as tendency for segregation.

$$\textbf{Flow percent} = \frac{D-25}{25} \times 100$$

D-SPREAD DIA METER in mm.

RESULT:

The flow percent of the concrete is ______________**%**

EX.NO:3
DATE:

COMPACTION FACTOR TEST

AIM:

To measure the workability of concrete by compaction factor test

APPARATUS REQUIRED:

Compaction factor test apparatus

PROCEDURE

1. The sample of concrete to be tested is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper.

2. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall in to the cylinder. In the case of a dry-mix, it is likely that the concrete may not fall on opening the trap-door

3. In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades.

4. The outside of the cylinder is wiped clean. The concrete is filled up exactly up to the top level of the cylinder.

5. It is weighed to the nearest **10 grams.** This weight is known as “ weight of partially compacted concrete”

6. The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep. The layers are heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighed to the nearest **10 gm.** This weight is known as “ weight of fully compacted concrete”

$$\textbf{Compaction factor} = \frac{\textbf{Weight of partially compacted concrerte}}{\textbf{Weight of fully compacted concrete}} \times 100$$

OBSERVATION AND CALCULATION:

Mass of cylinder W1:

Sl. no	Water Cement ratio	Mass with partially compacted concrete (W2) *grams*	Mass with fully compacted concrete (W3) *grams*	Mass with Partially compacted concrete (W2 – W1) *grams*	Mass with fully compacted concrete (W3 – W1) *grams*	C.F= (W2-W1)/ (W3-W1)
1						
2						
3						

RESULT:

The compaction factor of the given sample of concrete is_______________%

EX.NO:4

DATE:

VEE-BEE CONSISTOMETER

AIM:

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

APPARATUS REQUIRED:

Vee-Bee consistometer test apparatus

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 shape of concrete to change from slump cone shape to cylindrical shape in seconds is known as vee bee degree.

OBSERVATION AND CALCULATION:

Specifications	**Trial 1** ***sec***	**Trial 2** ***sec***
Initial reading on the graduated rod, A		
Final reading on the graduated rod, B		
Slump (B) – (A), **mm**		
Time for complete remolding, seconds		

RESULT:

The consistency of the concrete is ____________________ **seconds.**

EX.NO:5

DATE:

COMPRESSIVE STRENGTH OF CEMENT CONCRETE

AIM:

To determine the cube strength of the concrete of given properties

APPARATUS REQUIRED:

Moulds for the test cubes, tamping rods

PROCEDURE:

1. Calculate the material required for preparing the concrete of given proportions
2. Mix them thoroughly in mechanical mixer until uniform colour of concrete is obtained
3. Pour concrete in the oiled with a medium viscosity oil. Fill concrete is cube moulds in two layers each of approximately **75mm** and ramming each layer with **35 blows** evenly distributed 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.

OBSERVATION AND CALCULATION:

SPECIMAN	TRIALS			MEAN VALUE N/mm^2
	1	**2**	**3**	
LOAD ON CUBES *(kN)*				

RESULT:

The compressive strength of cement concrete is ________________**N/mm^2**

EX.NO:6

DATE:

FLEXTURE TEST ON HARDENED CONCRETE

AIM:

To determine the strength of the concrete by using flexure test

APPARATUS REQUIRED:

Prism mould, compression testing machine.

PROCEDURE.

1. Test specimens are stored in water at a temperature of **24^{0}C to 30^{0}C for 48 hours** before testing. They are tested immediately on removal from the water whilst they are still wet condition.
2. The dimension of each specimen should be noted before testing.
3. The bearing surface of the supporting and loading rollers is wiped and clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers.
4. The specimen is then placed in the machine in such manner that the load is applied to the upper most surface as cast in the mould
5. The axis of specimen is carefully aligned with the axis of the loading device. No packing is used between the bearing surfaces of the specimen and rollers.
6. The load is applied without shock and increasing continuously at a rate of the specimen. The rate of loading is **4kN/min for the 15cm specimen and 18 kN /min** for the **10cm specimen.**
7. The load is increased until the specimen fails and the maximum load applied to the specimen during the test is recorded

RESULT:

The strength of concrete is ________________**N/mm^2**

EX.NO:7

DATE:

SHAPE TEST (ELONGATION INDEX)

AIM:

To determine the Elongation index of the given aggregate sample.

APPARATUS REQUIRED:

Length gauge, I.S.Sieve

PROCEDURE

1. The sample is sieved through IS Sieve specified in the table. A minimum of **200 aggregate** pieces of each fraction is taken and weighed
2. Each fraction is the thus gauged individually for length in a length gauge. The gauge length is used should be those specified in the table for the appropriate material.
3. The pieces of aggregate from each fraction tested which could not pass through the specified gauge length with its long side are elongated particles and they are collected separately to find the total weight of aggregate retained on the length gauge from each fraction.
4. The total amount of elongated material retained by the length gauge is weighed to an accuracy of **at least 0.1%** of the weight of the test sample.
5. The weight of each fraction of aggregate passing and retained on specified sieves sizes are found as **W1, W2, W3, ……………** And the total weight of sample determined **W1+ W2+W3+……………..=Wg**. Also the weights of the material from each fraction retained on the specified gauge length are found = x_1, x_2, x_3**……** and the total weight retained determined = $x_1+x_2+x_3+$**……..=X gm.**
6. The elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged.

$$\text{Elongation index} = \frac{(x_1 + x_2 + x_3 + \ldots\ldots)}{(W_1 + W_2 + W_3 + \ldots)} \times 100$$

OBSERVATION AND CALCULATION:

Size of aggregate		Length gauge	Weight of the fraction consisting atleast 200 pieces *grams*	Weight of aggregate in each fraction retained on length gauge *grams*
Passing through IS sieve mm	Retained on IS sieve mm			
63	50	-		
50	40	81		
40	25	58		
31.5	25	-		
25	20	40.5		
20	16	32.4		
16	12.5	25.6		
12.5	10	20.2		
10	6.3	14.7		

CALCULATION:

RESULT:

The elongation index of a given sample of aggregate is ______________**%**

EX.NO:8
DATE:

SHAPE TEST (FLAKINESS INDEX)

AIM:

To determine the flakiness index of a given aggregate sample.

APPARATUS REQUIRED:

The apparatus consist of a standard thickness gauge, **IS Sieve of size 63, 50, 40, 31.5, 25, 20, 16, 12.5, 10 and 6.3 and a balance to weight the samples.**

PROCEDURE:

1. The sample is sieved with the sieves mentioned in the table.
2. A minimum of **200 pieces** of each fraction to be tested are taken and weighed **(W1 gm)**
3. In order to separate flaky materials, each fraction is then gauged for thickness on thickness gauge, or in bulk on sieve having elongated slots as specified in the table.
4. Then the amount of flaky materials passing the gauge is weighed to an accuracy of at least **0.1%** of test sample
5. Let the weight of the flaky materials passing the gauge be **W1gm.** Similarly the weights of the fractions passing and retained on the specified sieves be **W1, W2, W3,** etc, are weighed and the total weight **W1+W2+W3+…..**= Wg is found. Also the weights of the materials passing each of the specified thickness gauge are found =**W1, W2, W3….** And the total weight of the material passing the different thickness gauges = **W1+W2+W3…=Wg is found.**
6. Then the flakiness index is the total weight of the flaky material passing the various thickness gauges expressed as a percentage of the total weight of the sample gauged

$$\text{Flakiness index} = \frac{(w_1+w_2+w_3+\ldots\ldots)}{(W_1+W_2+W_3+\ldots\ldots)} \times 100$$

OBSERVATION AND CALCULATION:

Size of aggregate		Length gauge	Weight of the fraction consisting atleast 200 pieces	Weight of aggregate in each fraction retained on length gauge
Passing through IS sieve *mm*	Retained on IS sieve *mm*		*gm*	*gm*
63	50	33.90		
50	40	27		
40	25	19.50		
31.5	25	16.50		
25	20	13.50		
20	16	10.80		
16	12.5	8.55		
12.5	10	6.75		
10	6.3	4.89		

CALCULATION:

RESULT:

The flakiness index of the given sample of aggregates is ___________**%.**

EX.NO:9
DATE:

IMPACT TEST

AIM:

To determine the aggregate impact value of given aggregates

APPARATUS REQUIRED:

Impact testing machine, cylinder, tamping rod, **IS Sieve 125.mm, 10mm and 2.36mm, balance.**

PROCEDURE:

1. The test sample consists of aggregates passing **12.5mm** sieve and retained on 10mm sieve and dried in an oven **for 4 hours** at a temperature of **100^{o}C to 110^{o}C**
2. The aggregates are filled upto **about 1/3 full** in the cylindrical measure and tamped **25 times** with rounded end of the tamping rod
3. The rest of the cylindrical measure is filled by two layers and each layer being tamped **25 times.**
4. The overflow of aggregates in cylindrically measure is cut off by tamping rod using it has a straight edge.
5. Then the entire aggregate sample in a measuring cylinder is weighed nearing to **0.01gm**
6. The aggregates from the cylindrical measure are carefully transferred into the cup which is firmly fixed in position on the base plate of machine. Then it is tamped **25 times.**
7. The hammer is raised until its lower face is 38cm above the upper surface of aggregate in the cup and allowed to fall freely on the aggregates. The test sample is subjected to a total **of 15** such blows each being delivered at an interval of not less than one second. The crushed aggregate is than removed from the cup and the whole of it is sieved o**n 2.366mm** sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to **0.1gm.** Repeat the above steps with other fresh sample.
8. Let the original weight of the oven dry sample be W1gm and the weight of fraction passing **2.36mm IS sieve be W2gm.** Then aggregate impact value is expressed as the % of fines formed in terms of the total weight of the sample.

OBSERVATION AND CALCULATION:

Sl.no	Details of Sample	Trial 1 grams	Trial 2 grams	Trial 3 grams
1	Total weight of aggregate sample filling the cylinder measure **(W_1)**			
2	weight of aggregate passing 2.36mm sieve after the test **(W_2)**			
3	weight of aggregate passing 2.36mm sieve after the test **(W_2)**			
4	Aggregate impact value **=(W_1/ W_1) X 100**			**%**

RESULT:

The mean A.I.V is ______________**%**

EX.NO:10
DATE:

ABRASION TEST

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 gradings A, B, C and D, for gradings 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 orginal weight of aggregate be W1gm, weight of aggregate retained **on 1.70mm IS sieve after the test be W2gm.**

OBSERVATION AND CALCULATION

SL.NO	DETAILS OF SAMPLE	TRIAL 1	TRIAL 2	AVERAGE
1	Weight of sample = $\mathbf{W_1}$ **g**			
2	Weight of sample after abrastion test, coarser than 1.70mm IS sieve =$\mathbf{W_2}$**g**			
3	Percentage wear = $\mathbf{((W_1 – W_2)/W_1)*100}$			

CALCULATION:

RESULT:

The average value of Los Angles Abrastion Test is ________________**%**

EX.NO:11

DATE:

WATER ABSORPTION TEST ON COARSE AGGREGATE

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 **(W_1g)**
5) The dried coarse aggregate is immersed in clean water at a temperature **$27^o \pm 2^o$C for 24 hours.**
6) The coarse aggregate is removed from water and wiped out of traces of water with a cloth
7) Within three miniutes from the removal of water, the weight of coarse aggregate **W_2 is** found out
8) The above procedure is repeated for various samples.

OBSERVATION:

Sample No.	Weight of oven Dried specimen (W_1) grams	Weight of saturated specimen (W_2) grams	Weight of water Absorbed $W_3=(W_2-W_1)$ grams	% of water absorption $(W_3/W_1) \times 100$

CALCULATION:

RESULT:

Water absorption of the coarse aggregate is ____________**%**

EX.NO:12
DATE:

FLASH AND FIRE POINT TEST

AIM:

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

APPARATUS REQUIRED:

Pensky- martens closed cup tester, thermometer, heating source, flame exposure.

PROCEDURE:

1. All parts of the cup are cleaned and dried thoroughly before the test is started.
2. The material is filled in the cup upto a mark. The lid is placed to close the cup in a closed system. All accessories including thermometer of the specified range are suitably fixed.
3. The bitumen sample is then heated. The test flame is lit and adjusted in such a way that the size of a bed is of 4mm diameter. The heating o f sample is done at a rate **of 5^{o} to 6^{o}C per** minute. During heating the sample the stirring is done at a rate of approximately **60 revolutions per minute.**
4. The test flame is applied at intervals depending upon the expected flash and fire points and corresponding temperatures at which the material shows the sign of flash and fire are noted.

OBSERVATION AND CALCULATION:

TEST	TRIALS			MEANVALUE
	1 °C.	2 °C.	3 °C.	°C.
FLASH POINT				
FIRE POINT				

RESULT:

The temperature at which the flame application that causes a bright flash ____________ °C and temperature at which the sample catches fire ________________ °C.

EX.NO:13

DATE:

SPECIFIC GRAVITY TEST FOR BITUMEN

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 **W1gm**
2. Than it is filled with freah distilled water and then kept in water bath for at least half an hour at temperature **27^{0}C±0.1^{0}C.**
3. The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. Let this be **W2gm.**
4. Then the specific gravity bottle is emptied and cleaned. The bituminious 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 W3gm.
5. The remaining space in specific gravity bottle is filled with distilled water at **27^{0}C** and is weighed. Let this be **W4gm.**

$$\text{Specific gravity of bituminous material} = \frac{(W_3 - W_1)}{(W_2 - W_1) - (W_4 - W_3)}$$

RESULT:

The specific gravity of given bituminous binder is ________________

EX.NO:14

DATE:

DETERMINATION OF PENETRATION VALUE OF BITUMEN

AIM:

To determine the consistency of bituminous material

APPARATUS REQUIRED:

Penetration apparatus, thermometer, time measuring device, transfer dish, water bath, needle, container.

PROCEDURE.

1. Soften the material to a pouring consistency at a temperature not more than **60^{o}C** for tars **and 90^{o}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 atleast **10mm in** excess of the expected penetration. Protect the sample from dust

   and allow it to cool in an atmosphere at a temperature between **15^{o} to 30^{o}C** for one hour. Then place it along with the transfer dish in the water bath at **25.0^{o} ±0.1^{o}C** and allow it to remain for **1 to $1^{1}/_{2}$ hour**. The test is carried out at **25.0^{o} ±0.1^{o}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 onj completion of each determinations to avoid disturbance of the specimen.

RESULT:

The Penetration value of given bitumen is _________________**mm.**

EX.NO:15

DATE:

DETERMINATION OF SOFTENING POINT OF BITUMINOUS MATERIAL

AIM:

To determine the softening point of bitumen

APPARATUS REQUIRED:

Ring and Ball apparatus, Water bath with stirrer, Thermometer, Glycerin, etc. Steel balls each 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**. 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 knife.

2. Assemble the apparatus with the rings, thermometer and ball guides in position.

3. Fill the bath with distilled water to a height of 5**0mm** above the upper surface of the rings. The starting temperature should be **5^{o}C**

4. 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**

5. Note down the temperature when any of the steel ball with bituminous coating touches the bottom plate.

RECORD AND OBSERVATION:

Specification	**1**	**2**
Temperature when the ball touches bottom, ^{o}C		
Average softening point of bitumen		

RESULT:

The Softening value of given bitumen is ________________

EX.NO:16

DATE:

DETERMINATION OF DUCTILITY OF THE BITUMEN

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 precaliberated rate, a putty knife, thermometer.

PROCEDURE

1. Melt the bituminous test material completely at a temperature of **75^{o}C to 100^{o}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 place it on a 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^{o}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. Replace the mould assembly in water bath maintained at **27^{o}C for 80 to 90** minutes
8. Remove the sides of the moulds
9. Hook the clips carefully on the machine without causing any initial strain

10. Adjust the pointer to read zero
11. Start the machine and pull two clips horizontally at a speed of **50mm** per minute
12. Note the distance at which the bitumen thread of specimen breaks.
13. Record the observations in the proforma and compute the ductility value report the mean of two observations, rounded to nearest whole number as the "**Ductility Value**"

RECORD AND OBSERVATIONS:

I. Bitumen grade =

_II. Pouring temperature ^{o}C =

III. Test temperature ^{o}C =

IV. Periods of cooling, minutes =

- **a) In air** =
- **b) In water bath before trimming** =
- **c) In water bath after trimming** =

RESULT:

The Ductility value of given bitumen is ________________ **mm.**

EX.NO:17

DATE:

DETERMINATION OF VISCOSITY OF BITUMINOUS MATERIAL

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. Adjust the tar viscometer so that the top of the tar cup is leveled. Select the test temperature. Heat the water in water bath to the temperature specified for the test and maintains it within **±0.1^{o}C** of the specified temperature throughout the duration of test. Rotate the stirrer gently at frequent intervals or perfectly 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^{o}C** above the temperature specified for test and cool, while continuing the stirring.
4. When the temperature falls slightly above the specified temperature, pour the tar into the cup until the leveling peg on the valve rod is just immersed when the latter is vertical.
5. Pour into the graduated receiver **20ml** of mineral oil, or one percent by weight solution of soft soap, and place it under the orifice of the tar cup.
6. Place the other thermometer in the tar and stir until the temperature is **within ±0.1^{o}C** of the specified temperature. When this temperature has been reached, suspend the thermometer coaxially with the cup and with its bulb approximately at the geometric center of the tar.

7. Allow the assembled apparatus to stand for five minutes during which period the thermometer reading should remain within **0.05^{o}C** of the specified temperature. Remove the thermometer and quickly remove any excess of tar so that the final level is on the central line of the leveling peg when the valve is in vertical position.

8. Lift the valve and suspend it on valve support

9. Start the stop watch when the reading in the cylinder is **25ml** and stop it when it is **75ml.** note the time in seconds

10. Report the viscosity as the time taken in seconds by **50ml** of tar to flow out at the temperature specified for the test.

RECORD AND OBSERVATION:

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

RESULT:

The Viscosity value of given bitumen is ________________**Seconds.**

EX.NO:18

DATE:

DETERMINATION OF BITUMEN CONTENT BY CENTRIFUGE EXTRACTOR

AIM:

To determine quantity of bitumen in hot- mix paving mixtures and pavement samples Apparatus required:

PROCEDURE:

1. Weight a **1000 grams** sample of asphalt mix.
2. With the fork break the sample down to small pieces and heat the sample to about **115^{o}C.**
3. Place the sample in the bowl and weight it.
4. Cover the sample in the bowl with benzene or trichloroethane and allow it to soak for one hour.
5. Weight filter ring. Place it around the edge of the bowl and clamp a lid on the bowl.
6. Place a beaker under the outlet.
7. Place the bowl in a centrifuge and rotate it gradually to increase the speed upto **3600rpm.** Rotate until the solvent ceases to flow from the outlet.
8. Stop the centrifuge, add **200ml** of trichoroethane or benzene and rotate it again.
9. Repeat the procedure until the extract is no longer cloudy and if fairly light in color.
10. Remove the filter from the bowl and dry in air.
11. Brush the loose particles from the filter into the bowl.
12. Dry the filter to constant weight in a oven at **98^{o}C to 105^{o}C**

13. Dry the contents of the bowl on a steam bath and then to constant in an oven at **98 °C** to **105°C**

14. Obtain the weight of the filter and bowl with dry aggregates.

RECORD AND OBSERVATION:

BEFORE TEST:

Weight of bowl + sample (W1)_______________ grams

Weight of bowl (W2) _______________grams

Weight of filter (W3) _______________grams

AFTER TEST:

Weight of bowl + sample (W4) ________________grams

Weight of filter (W5) ________________grams

Weight of sample (W1-W2) ____________grams

Weight of aggregate in bowl (W4-W2)____________ grams

RESULT:

The percentage of the bitumen in the given sample is ________________**%**

EX.NO:19

DATE:

BITUMINOUS MIX DESIGN BY MARSHALL METHOD

AIM:

To determine optimum binder content of given bituminous mix by marshall method of mix design.

APPARATUS REQUIRED:

Mould assembly, sample extractor, compaction pedestal and hammer, breaking head, loading machine flow meter, thermometers water bath and oven

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.**

3. 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.

4. Then the mix is heated and a temperature of **150^{o} to 160^{o}C** is maintained and then the mix is transferred into the pre-heated mould and compacted by giving seventy five blows on each side.

5. The specific gravity values of different aggregates, filler and bitumen used are determined first. The theoretical specific gravity of the mix is determined.

6. 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.

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

8. Then the specimen to be tested is kept immersed under water in a thermostatically controlled water bath maintained at **$60^o \pm 1^o$C for 30 to 40** minutes.

9. The specimens are taken out one, placed in the marshal test and the marshal stability value and flow are noted.

10. 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**.

11. 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.

12. Let the bitumen contents corresponding to maximum density **be B_1**, corresponding to maximum 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 ______________