RAJALAKSHMI ENGINEERING COLLEGE

CE 2307 - CONCRETE & HIGHWAY ENGG. LAB

V SEMSTER – CIVIL ENGG.

Prepared By

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Department of Civil Engg.

STAFF INCHARGE **HOD/CIVIL ENGG.**

LAB MANUAL

CE 2307 - CONCRETE & HIGHWAY ENGG. LAB

LIST OF EXPERIMENTS

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

TEST ON HARDENED CONCRETE

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TEST ON BITUMEN

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3. DUCTILITY
4. VISCOSITY
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4. DENSITY

RAJALAKSHMI ENGINEERING COLLEGE

DEPARTMENT OF CIVIL ENGINEERING

CONCRETE AND HIGHWAY MATERIALS LABORATORY

EXPERIMENTAL EVALUATION SHEET

Name of the student: **Date:**

Register number:

Name of the Experiment:

Sl. no.	Evaluation parameter	Grade	Remarks
	Performance of Experiment		
	Innovativeness		
	Equipment details		
	Analytical Skill		
	Presentation of results		
	Group Discussion		
	Viva voce		
	TOTAL		

Signature of Staff in-charge:

Department of Civil Engineering, R.E.C
Prepared by: Prof.S.Lavanya Praba

SLUMP CONE TEST

Exp No: Date:

Aim:

To measure the consistency of concrete by using slump cone

Apparatus required:

Slump cone, tamping rod, metallic sheet.

Procedure.

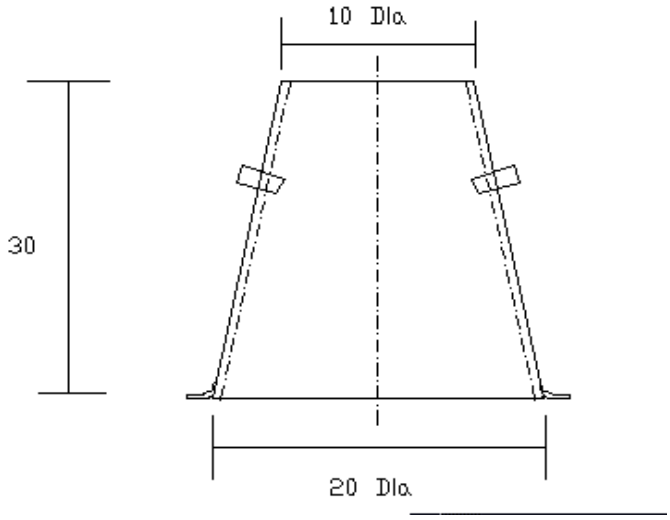
1. The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.
2. The mould is placed on a smooth, horizontal rigid and non – absorbent surface.
3. The mould is then filled in four layers each approximately ¼ 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 half 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. Shear slump also indicates that the concrete is non-cohesive and shows the characteristic of segregation.

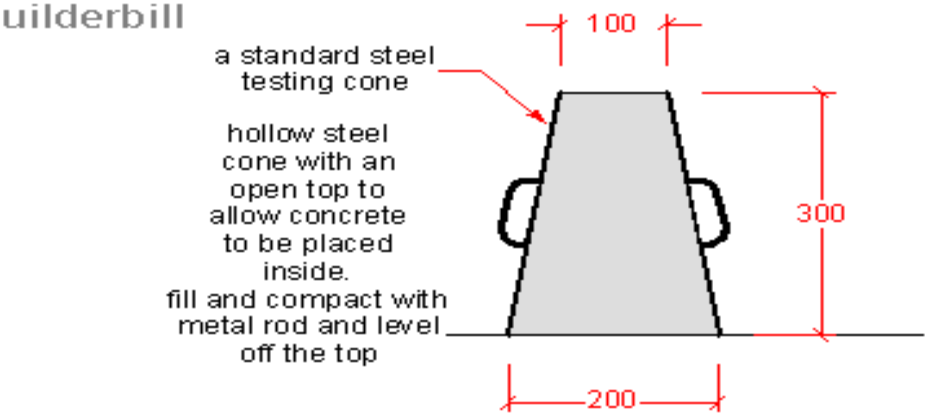
Result:

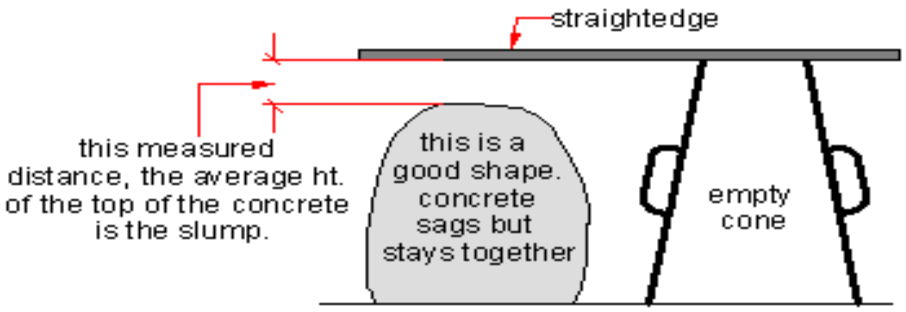
The slump value of the concrete is _____

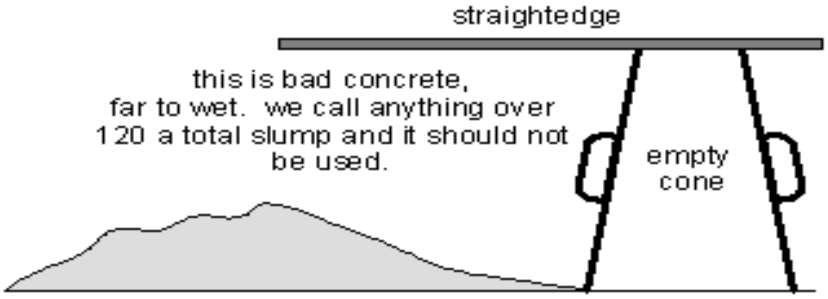
Viva Voce:

1. What is meaning of Consistancy in concrete?
2. What is slump of concrete?
3. What is the significance of shear slump?
4. What is segregation?









FLOW TABLE TEST

Exp No: Date:

Aim:

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

Apparatus required:

Flow table test apparatus

Procedure.

The apparatus consists of flow table about 76cm. in diameter over which concentric circles are marked. A mould made from smooth metal casing in the form of a frustum of a cone is used with the following internal dimensions. The base is 25cm. in diameter upper surface 17cm. in diameter and height of the cone is 12cm.

1. The table top is cleaned of all gritty material and is wetted. The mould is kept on the center of the table, firmly held and is filled in two layers.
2. Each layer is rodded 25 times with a tamping rod 1.6cm in diameter and 61cm long rounded at the lower tamping end.
3. After the top layer is rodded evenly the excess of concrete which has overflowed the mould is removed.
4. The mould if lifted vertically upward and the concrete stands on its own without support. The table is then raised and dropped 12.5cm 15times in about 15 seconds.
5. The diameter of the spread concrete is measured in about 6 directions to the nearest 5mm and the average spread is noted. The flow of concrete is the percentage 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 per cent. A close look at the pattern of spread of concrete can also give a good indication of the characteristics of concrete such as tendency for segregation.

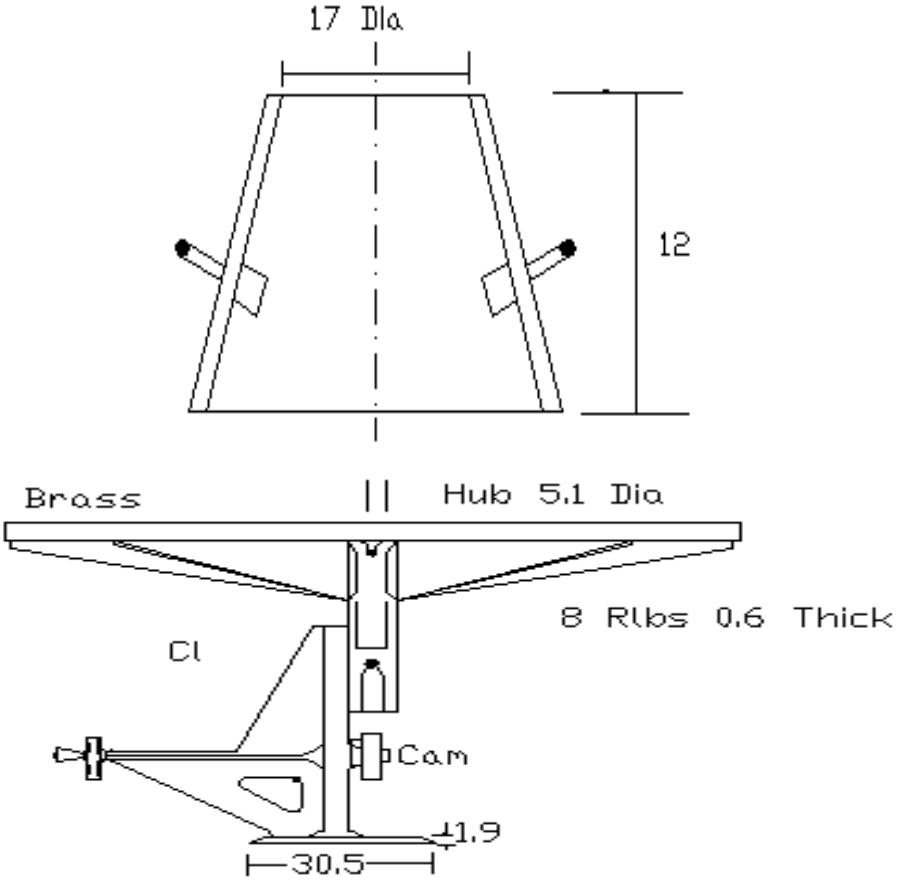
$$\text{Flow, per cent} = \frac{\text{Spread diameter in cm} - 25}{25} \times 100$$

Result:

The flow percent of the concrete is

Viva Voce:

1. Define workability of concrete?
2. What is the significance of flow test?
3. What is the water cement ratio for workable concrete?



FLOW TABLE APPARATUS

COMPACTION FACTOR TEST

Exp No: Date:

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"

$$\text{The compaction factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}$$

Result:

The compaction factor of the given sample of concrete is_____%

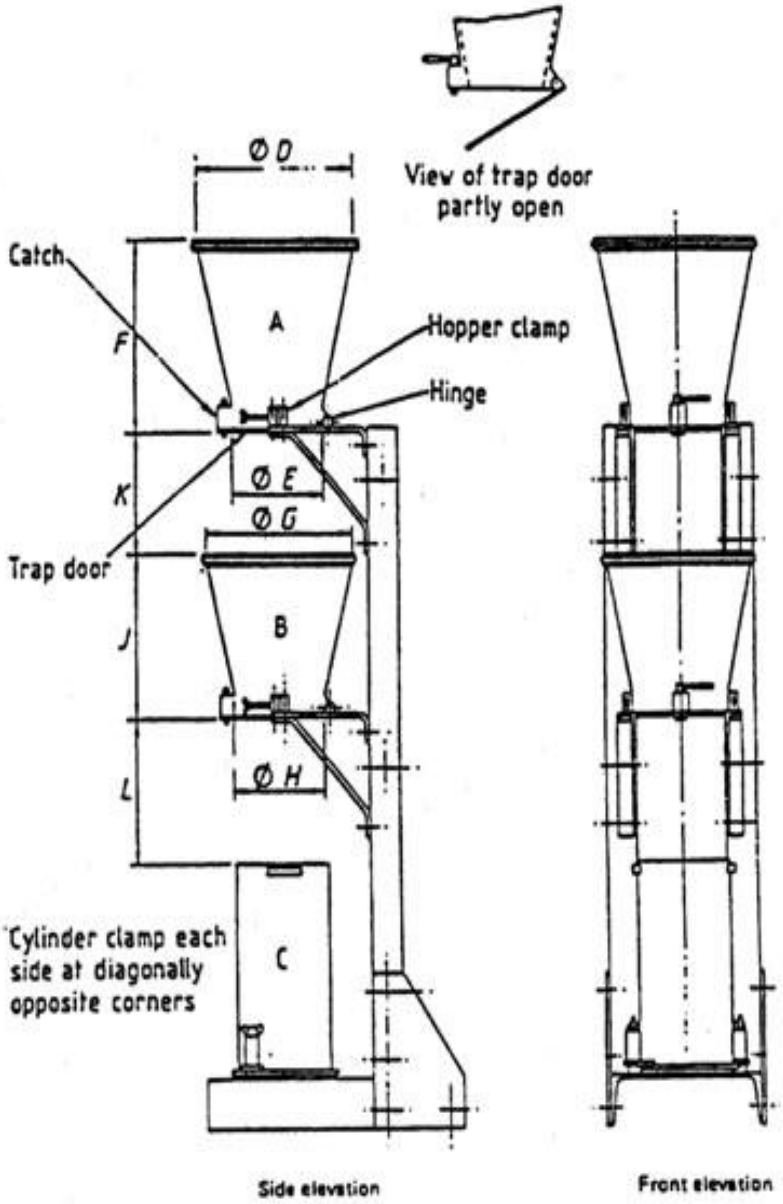
Viva Voce:

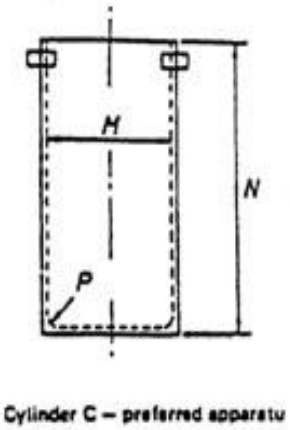
1. What is the difference between fully compacted and partially compacted concrete?
2. What is the significance of compacted concrete?
3. Define density of concrete & how it affects the strength of concrete?

Observation and Calculation:

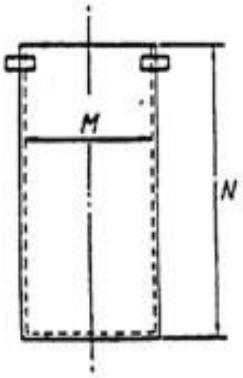
Mass of cylinder W1:

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





Cylinder C — preferred apparatu



Cylinder C — alternative appara

VEE-BEE CONSISTOMETER

Exp No: Date:

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

Observation and Calculation:

Initial reading on the graduated rod, a		
Final reading on the graduated rod, b		
Slump (b) – (a), mm		
Time for complete remoulding, seconds		

Result:

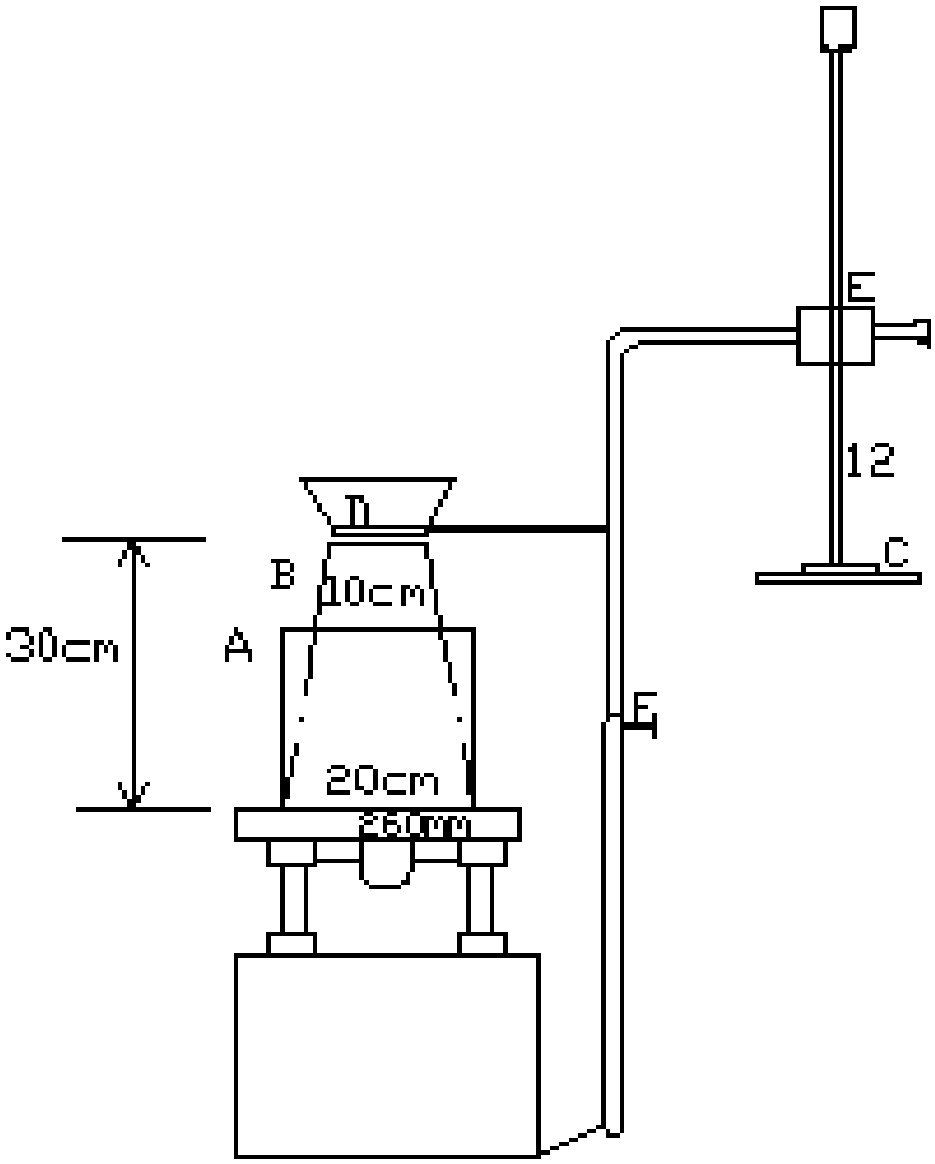
The consistency of the concrete is _____ sec.

Viva Voce:

1. Describe the factors affecting the choice of the method of test.
2. What are the advantages and disadvantages of Vee-Bee method of test over the other Methods?

References:

1. Neville. A. M, Properties of concrete, 3 edition, Pitman publishing company, 1981. rd
2. Gambhir. M. L, Concrete manual, 4 edition, Dhanpat Rai and Sons, Delhi. th



A= cylindrical pot

B= sheet metal cone

C= glass disc

D= swivel arm

E=glass disc adjustable screw

F= adjustable screw

VEE BEE CONSISTOMETER

COMPRESSIVE STRENGTH OF CEMENT CONCRETE

Exp No: Date:

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:

Specimen	Trials			Mean Value N/mm^2
	1	2	3	
Load on cubes, KN				

Result:

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

Viva Voce:

1. How does strength correlate with other properties of hardened concrete?
2. What are the requirements for curing the specimens?
3. What is the rate of loading in flexure test?

Reference:

1. Indian Standard, Recommended Guidelines for Concrete Mix Design, IS: 10262
2. Neville. A. M, Properties of concrete, 3 edition, Pitman publishing company,1981.
3. Gambhir. M. L, Concrete manual, 4 edition, Dhanpat Rai and Sons, Delhi.

FLEXTURE TEST ON HARDENED CONCRETE

Exp No: Date:

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°C to 30°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

Viva Voce:

1. What is the bending equation?
2. What is the bending stress for 'T' section?
3. What is the significance of moment of inertia with respect to bending stress?
4. How does the centroid affects the bending stress for different shapes of beams?

SHAPE TEST (ELONGATION INDEX)

Exp No: Date:

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 – 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.

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

Result:

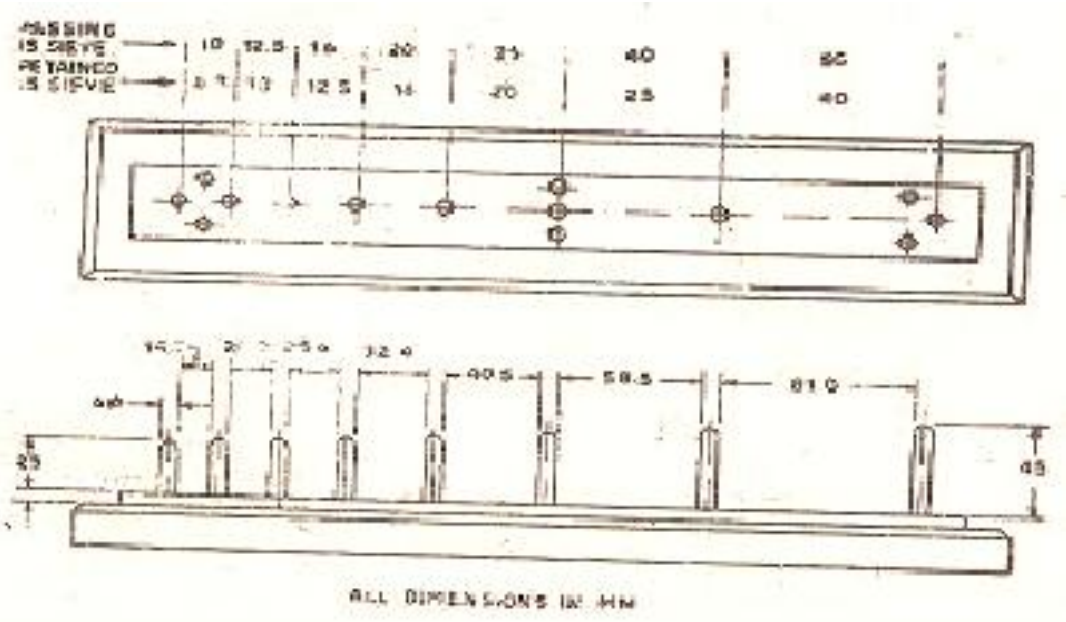
The elongation index of a given sample of aggregate is _____%

Viva Voce:

1. What do you mean by elongation index of an aggregate?
2. What do you infer from elongation index?
3. How the elongation index of the sample helps in deciding the design of a highway?

Observation and Calculation:

Size of aggregate		Length Gauge	Weight of the fraction consisting of atleast 200 pieces in gm	Weight of aggregates in each fraction retained on length gauge gm.
Passing through IS Sieve mm	Retained on IS Sieve mm			
63	50	-		
50	40	81		
40	25	58.50		
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		



Elongation Index Test in Progress

SHAPE TEST (FLAKINESS INDEX)

Exp No: Date:

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 atleast 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

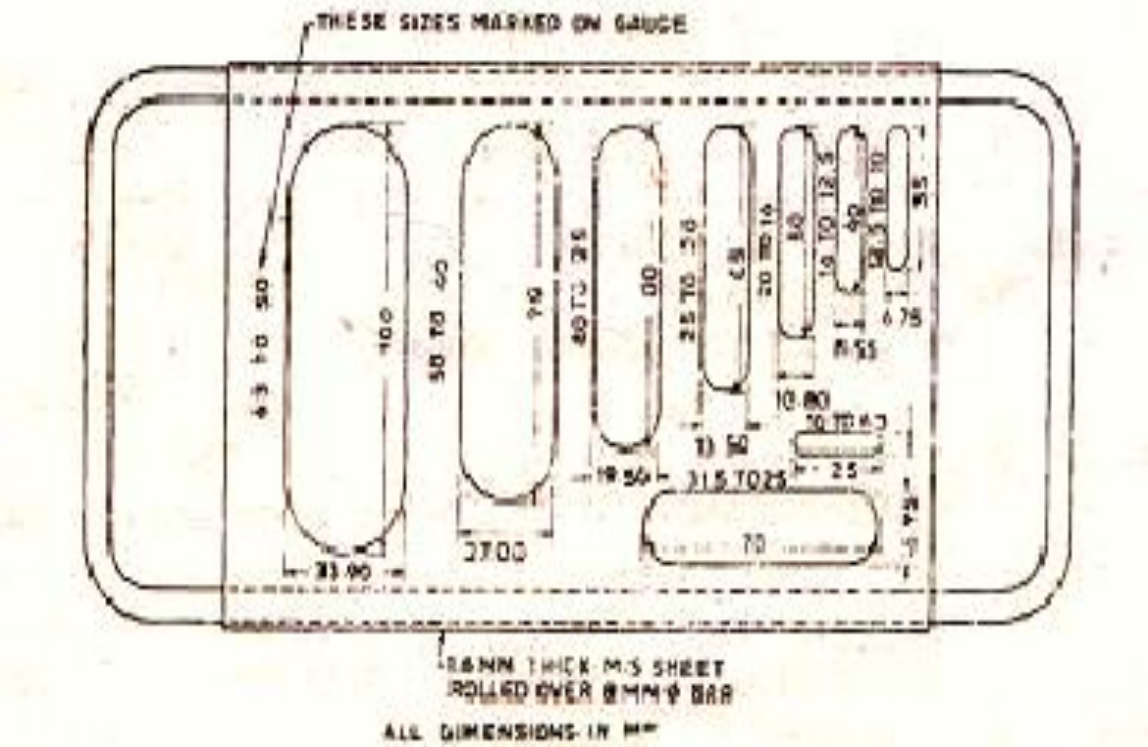
$$\text{Flakiness index} = \frac{(w1+w2+w3+\ldots\ldots\ldots..)}{(W1+W2+W3+\ldots\ldots\ldots\ldots)} \times 100$$

Result:

The flakiness index of the given sample of aggregates is _____%.

Viva Voce:

1. What do you mean by flakiness index of an aggregate?
2. What do you infer from flakiness index?
3. How the flakiness index of the sample helps in deciding the design of a highway?



Flakiness Index Test in Progress

Observation and Calculation:

Size of aggregate		Thickness gauge (0.6 times the mean sieve) mm	Weight of the fraction consisting of atleast 200 pieces in gm	Weight of aggregates in each fraction passing thickness gauge gm.
Passing through IS Sieve mm	Retained on IS Sieve mm			
63	50	33.90		
50	40	27.00		
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		

IMPACT TEST

Exp No: Date:

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 on 2.366mm sieve until no significant amount passes. The fraction passing the sieve is weighed accurate to 0.1gm. Repeat the above steps with other fresh sample.
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.

Result:

The mean A.I.V is _____%

Viva voce:

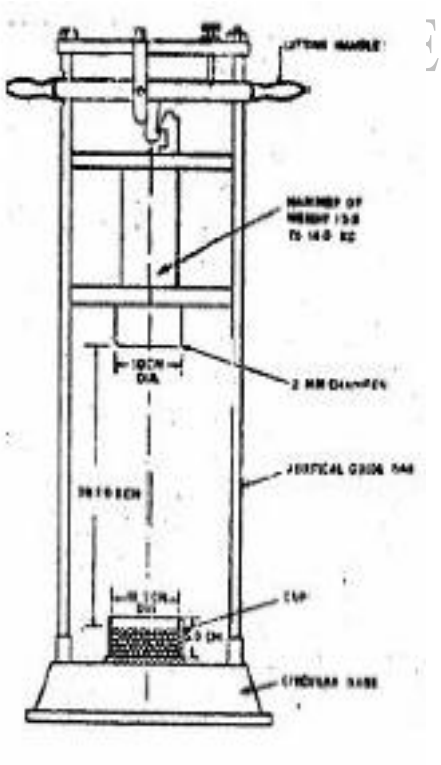
1. How is aggregate Impact expressed?
2. What do you understand by dry and wet Impact value?
3. Aggregate Impact value of material A is 15 and that of B is 35. Which one is better for surface course?

Reference:

1. Indian Standard Methods of Test for Aggregate for concrete IS: 2386 Part-IV, Indian Standards Institution.
2. Indian Standard Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete, IS: 383 Indian Standards Institution.
3. S.K. Khanna, C.E.G. Justo, Highway Material Testing Laboratory Manual, Nem Chand & Bros., Roorkee.

Observation and calculation:

Sl.no	Details of Sample	Trial 1	Trial 2	Trial 3
1	Total weight of aggregate sample filling the cylinder measure = W1g			
2	Weight of aggregate passing 2.36mm sieve after the test =W2g			
3	Weight of aggregate retained 2.36mm sieve after the test = W2g			
4	(W1 – W2 + W3)			
5	Aggregate impact value = (W2 / W1)*100 Percent			



Aggregate Impact Testing Machine

ABRASION TEST

Exp No: 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 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 = W1g			
2	Weight of sample after abrastion test, coarser than 1.70mm IS sieve =W2g			
3	Percentage wear = ((W1 – W2)/W1)*100			

Result:

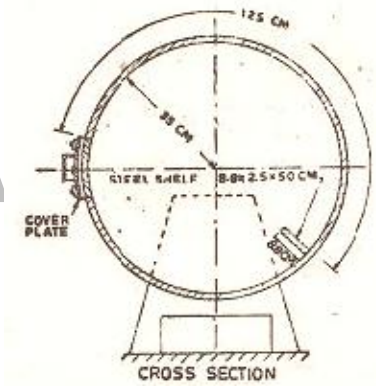
The average value of Los Angles Abrastion Test is _____%

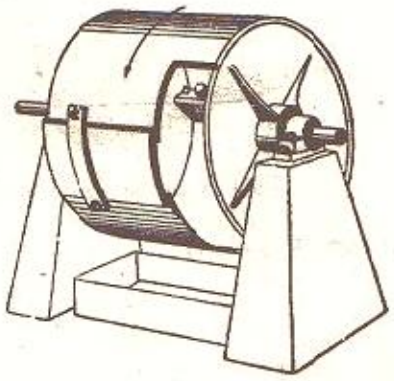
Viva voce:

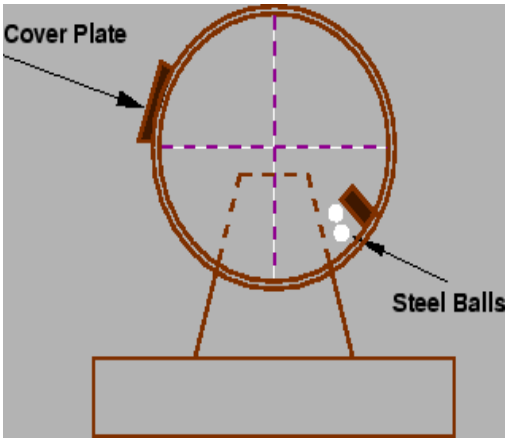
1. The abrasion value found from Los Angeles test for two aggregates A and B are 50% and 38% respectively. Which aggregate is harder? Why? For what types of constructions are these suitable?
2. Why Los Angeles abrasion test is considered superior to the other form of tests which are used to determine the hardness of aggregates?
3. Two materials have abrasion values 3 and 10 respectively. Which one is harder and why?

Reference:

1. Indian Standard Methods of Test for Aggregate for concrete IS: 2386 Part-IV, Indian Standards Institution.
2. Indian Standard Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete, IS: 383 Indian Standards Institution.
3. S.K. Khanna, C.E.G. Justo, Highway Material Testing Laboratory Manual, Nem Chand & Bros., Roorkee.







Los Angeles Abrasion Testing Machine

WATER ABSORPTION TEST ON COARSE AGGREGATE

Exp No: 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 (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 and Calculation:

Sample No.	Weight of oven dired specimen (W_1) g	Weight of saturated specimen (W_2) g	Weight of water absorbed $W_3=(W_2-W_1)$ g	% of water absorption $=(W_3/W_1) \times 100$

Weight of dry sample of coarse aggregate W_1 =

Weight of saturated specimen W_2 =

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

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

Result:

Water absorption of the coarse aggregate is _____

Viva voce:

1. How does the Water absorption of the coarse aggregate affects the mix design of concrete?

FLASH AND FIRE POINT TEST

Exp No: Date:

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 of sample is done at a rate of 5^o to 6^oC 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			Mean value
	1	2	3	
Flash Point				
Fire Point				

Result:

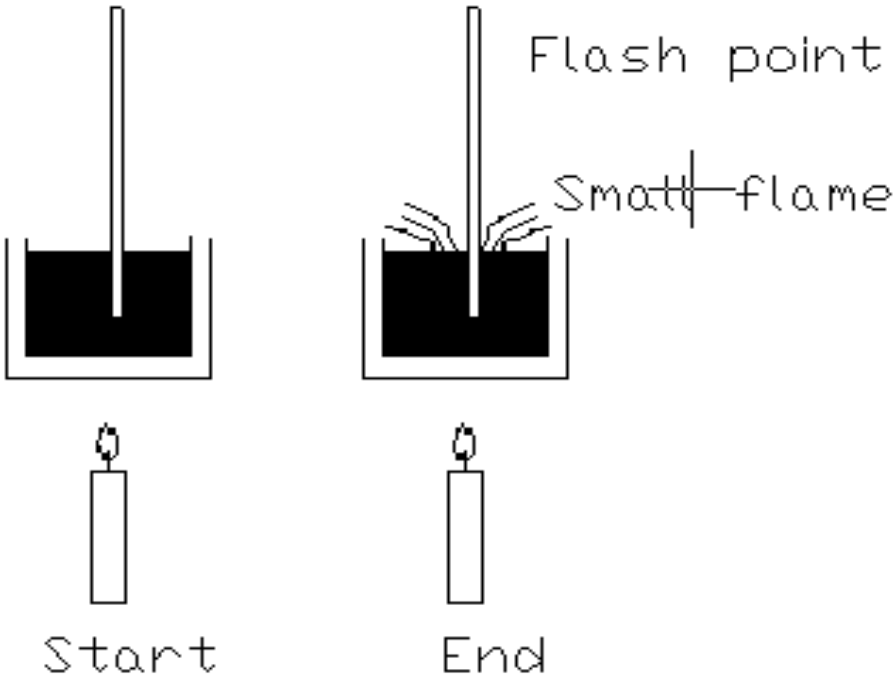
The temperature at which the flame application that causes a bright flash _____^oC and temperature at which the sample catches fire _____^oC.

Viva Voce:

1. Define flash and fire points.
2. What is the significance of flash and fire point test?
3. What are the parameter that affects the result of flash and fire point tests?

References:

1. Indian Standard Method for Tar and Bitumen, Determination of Flash and Fire Point of Bitumen, IS: 1209, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen, IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.



Flash and Fire Point Test in Progress

SPECIFIC GRAVITY TEST FOR BITUMEN

Exp No: 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 W1gm
2. Than it is filled with freah distilled water and then kept in water bath for at least half an hour at temperature $27^{o}C \pm 0.1^{o}C$.
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 $27^{o}C$ and is weighed. Let this be W4gm. Then specific gravity of bituminous material is given by formula.

$$= \frac{(W3 - W1)}{(W2 - W1) - (W4 - W3)}$$

Result:

The specific gravity of given bituminous binder is _____

Viva Voce:

1. Define specific gravity.
2. What is the use of finding specific gravity?
3. What are the factors affecting specific gravity test?

References:

1. Indian Standard Method for Tar and Bitumen, Determination of Specific Gravity of Bitumen IS: 1202, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.

DETERMINATION OF PENETRATION VALUE OF BITUMEN

Exp No: Date:

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:

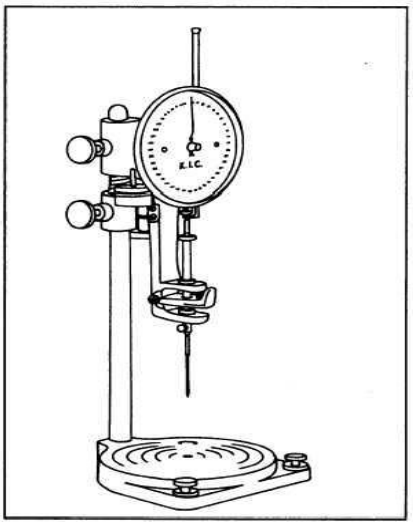
The Penetration value of given bitumin is _____

Viva Voce:

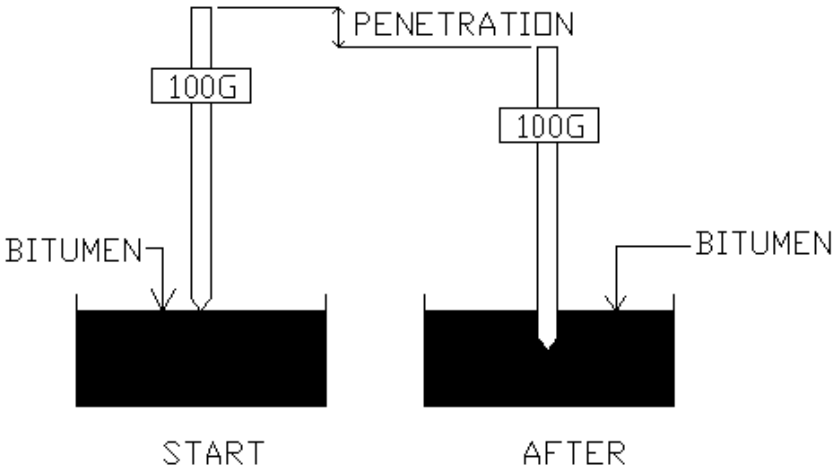
1. What are the applications of penetration test?
2. What do you understand by the term 30/40 bitumen?
3. What are the precautions to be taken while conducting a penetration test?

References:

1. Indian Standard Method for Tar and Bitumen, Determination of Penetration of Bitumen, IS: 1203, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen, IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.



PENETRATION TEST APPARATUS



PENETRATION TEST CONCEPT

DETERMINATION OF SOFTENING POINT OF BITUMINOUS MATERIAL

Exp No: Date:

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 50mm 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:

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

Result:

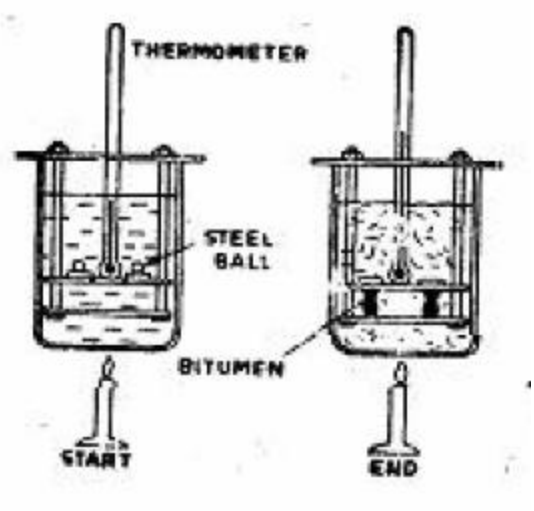
The Softening value of given bitumen is _____

Viva Voce:

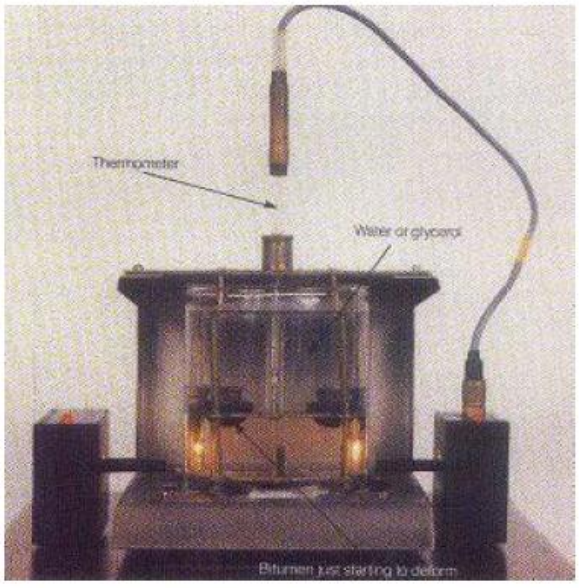
1. What are the factors which affect the ring and ball test results?
2. What is softening point?
   If material A has softening point of 56 and B has 42 which binder is good and why?

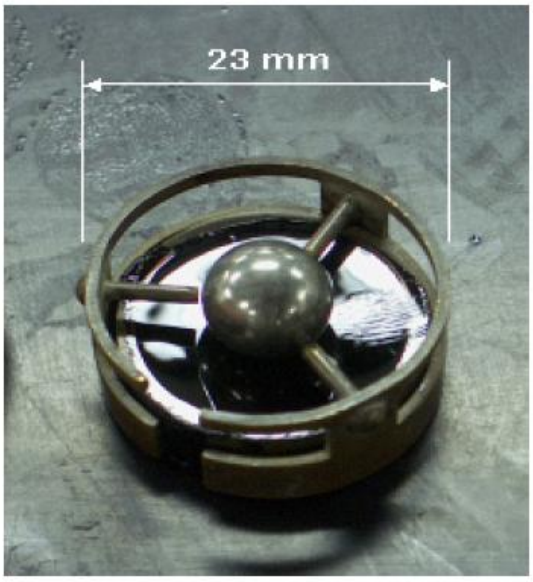
References:

1. Indian Standard Method for Tar and Bitumen, Determination of Softening Point of Bitumen, IS: 1205, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen, IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.



Softening Test Concept





Softening Point Apparatus and Ring and Ball Guides

DETERMINATION OF DUCTILITY OF THE BITUMEN

Exp No: 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
3.

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 and a pulling device at a precaliberated 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 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°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°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 °C =
III. Test temperature °C =
IV. Periods of cooling, minutes =
   a) In air =
   b) In water bath before trimming =
   c) In water bath after trimming =

	1	2	3
a) Initial reading			
b) Final reading			
c) Ductility = b-a (cm)			
Ductility Value			

Result:

The Ductility value of given bitumin is _____

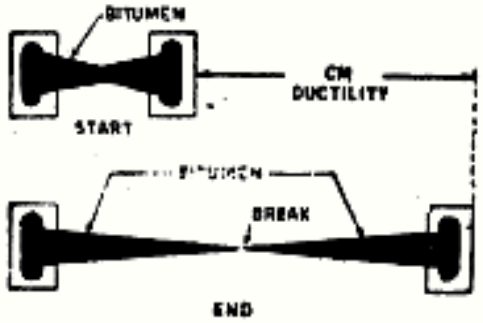
Viva Voce:

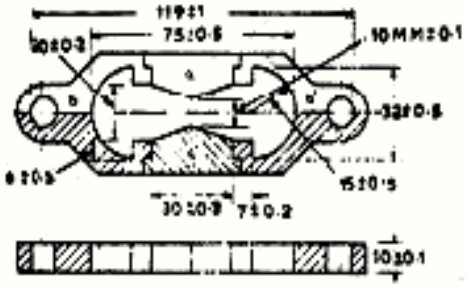
1. List the factors that affect the result of a ductility test.
2. What do you understand by the term repeatability and reproducibility?
3. Explain the significance of ductility test.

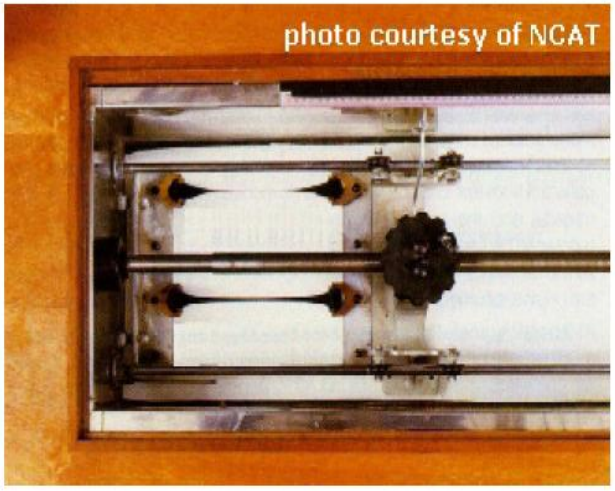
References:

1. Indian Standard Method for Tar and Bitumen, Determination of Ductility of Bitumen, IS: 1208, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen, IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.

Length	...	75 mm
Distance between clips	...	30 mm
Width at mouth of clips	...	20 mm
Cross section at minimum width	...	10 mm × 10 mm







Sample Prepared in Briquette Mould and Ductility Apparatus

DETERMINATION OF VISCOSITY OF BITUMINOUS MATERIAL

Exp No: 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. 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:

		Test 1	Test 2
Test temperature	=		
Time taken to flow 50cc			
Of the binder	=		
Viscosity	=	sec	

Result:

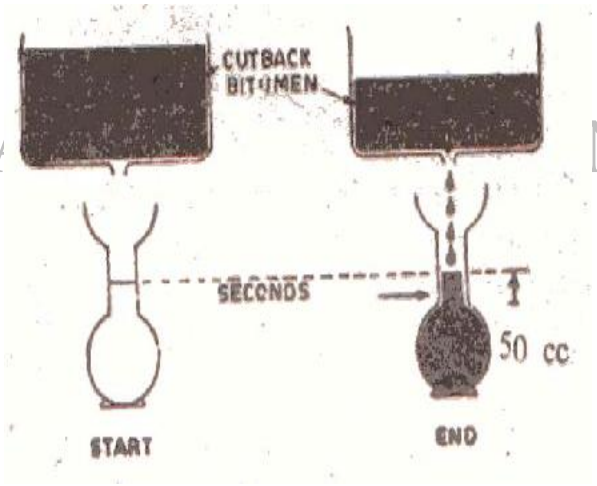
The Viscosity value of given bitumen is _____

Viva Voce:

1. Explain the term viscosity.
2. What are the uses of viscosity test?
3. What are the precautions to be taken during viscosity test using orifice viscometer?

References:

1. Indian Standard Method for Tar and Bitumen, Determination of Viscosity of Bitumen, IS: 1206, Indian Standards Institution.
2. Indian Standard Specification for Paving Bitumen, IS: 73.
3. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.



Standard Tar Viscometer

DETERMINATION OF BITUMEN CONTENT BY CENTRIFUGE EXTRACTOR

Exp No: Date:

Aim:

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

Apparatus required:

Procedure:

1. Weight a 1000g 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^{0}C to 105^{o}C
14. Obtain the weight of the filter and bowl with dry aggregates.

Result:

The percentage of the bitumen in the given sample is _____

Record and Observation:

Before Test

Weight of bowl + sample (W1)g

Weight of bowl (W2)g

Weight of filter (W3)g

After Test

Weight of bowl + sample (W4) g

Weight of filter (W5) g

Weight of sample (W1-W2) g

Weight of aggregate in bowl (W4-W2)

BITUMINOUS MIS DESIGN BY MARSHALL METHOD

Exp No: Date:

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 of 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} ±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, i9f 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:

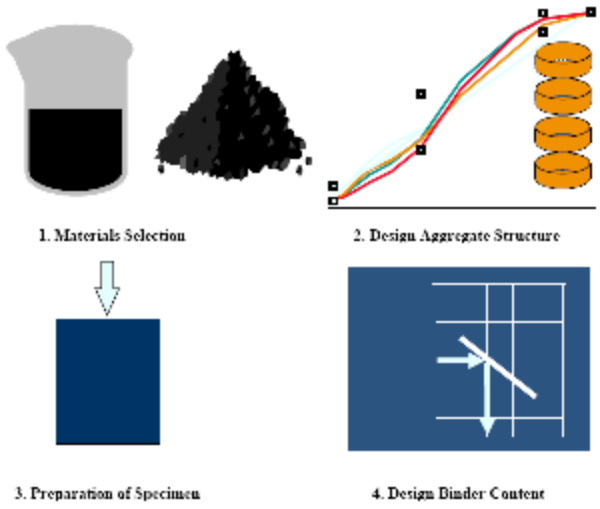
The optimum binder content of the given mix is _____

Viva Voce:

1. What is the significance of flow value in Marshall Test?
2. What is filler?
3. What are the essential properties of bituminous mixes?

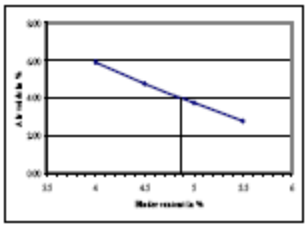
Reference:

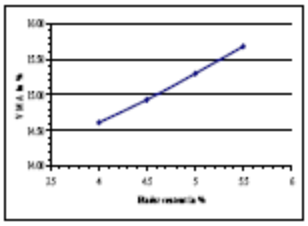
1. S.K. Khanna and C.E.G Justo, Highway Materials Testing Laboratory Manual, Nem Chand Bros. Roorkee.
2. Ministry of Road Highway Transport, fourth revisions, by Indian Road Congress.

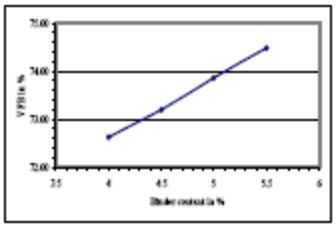


Steps Showing the Procedure of Marshall Mix Design

GE







Pictorial Representation of Marshall Mix Design