CMR
INSTITUTE OF
TECHNOLOGY

Internal Assessment Test 1 – Sep. 2018

Scheme and Solution

Sub:	Pavement Materials and Construction					Sub Code:	10CV763	Branch:	Civil
Date:	17/10/2018	Duration:	90 mins	Max Marks:	50	Sem/Sec:	VII (Parallel Class)		

1. List the various adhesion tests conducted on bituminous mixes. Explain in detail.

It is desirable that there should be a reliable method of determining in the laboratory whether or not a bituminous binder will adhere to an aggregate in the presence of water. Studies of the physio chemical properties of the binder/ stone/ water system have so far not proved sufficient conclusion to develop a rational approach of testing the materials.
This has led to develop arbitrary tests which may be used to examine the various combinations of road stones and binder used in bituminous road construction. Such tests may also be used to study the effect of an particular variable on the behavior of the binder/ stone/ water system.
Several tests have been described most of which fall into six basic types, they are.

- Static immersion tests.
- Dynamic immersion tests
- Chemical immersion tests
- Immersion mechanical tests
- Immersion trafficking tests
- Coating tests

Static immersion tests
In this type of tests aggregate coated with binder is immersed in water and degree of stripping is estimated. The method consists of single sized chipping which are coated with a constant quantity of binder under carefully controlled conditions and the coated stone is then immersed in distilled water and allowed to stand at a controlled temperature for up to 48 hours. The percentage of stripped surface is estimated visually. The results obtained in this test are not standardized and leads to poor reproducibility. In order to improve the test several agencies have tried to adopt other methods of assessing the degree of stripping. One approach is to measure the quantity of light reflected by the sample of coated aggregate before and after immersion in water. Another is to coat the aggregate with a solution of a radio- active calcium salt before it is coated with binder so that, when stripping occurs, the salt dissolves in water and the rise in radio activity of the water may be followed.
This method is fundamental because the interface which is studied is no longer between binder and stone but instead between binder and calcium salt. It is known that small amounts of materials such as calcium salts may sometimes have a effect on stripping of binders from the aggregate. When studied by a static immersion test. Though the test gives difficulties with reproducibility the test frequency gives some idea of how a mixture of aggregate and binder may behave on the road.

Dynamic immersion tests

This type of test is similar in general principle to the static immersion test., but the sample is agitated mechanic ally by shaking or kneading. The method of assessing the degree of stripping in such tests may involve visual estimation which again is usually not very satisfactory or determination of the quantity of uncoated aggregate which separates from the original sample.

The Nicholson wash test is typical of several dynamic immersion tests. In this coated aggregate is

shaken in water for a known time and then the amount of stripping is estimated usually.

Chemical immersion tests

The Best known example of this type of test is that described by Riedel and Weber, but others of similar type also exist. In the Riedel and Weber test sand coated with binder is boiled successively in distilled water and if necessary, in solutions of gradually increasing concentrations of sodium carbonate. The strength of the solution of sodium carbonate in which stripping in first observed is used as a measure of the adhesively. Attempts have been made to improve this test, for example by reducing the temperature and using larger stone, or by measuring the amount of uncoated aggregate which separates from the coated mass. The artificial conditions of the test make it of doubtful value in reproducing road performance although it has been widely used probably because it gives a numerical answer and is very easily carried out.

Immersion mechanical tests

Immersion mechanical tests are in essence static immersion tests in which the degree of stripping of the binder from the aggregate is observed indirectly by measuring the change in a specified mechanical property of a sample of bituminous material after it has been immersed in water . In order that a mechanical test can be used it is necessary to employ a graded aggregate rather than single sized stone.

The mechanical properties which may be measured include shear strength, tensile strength, flexural strength, compressive strength, resistance to penetration of a cone and resistance to abrasion. In this test a number of identical cylindrical specimens of bituminous mixture to be tested are prepared. After a few hours of curing some are used to determine the compressive strength of the mixture under a constant rate of strain. The reminder are immersed in water for some days and then tested similarly.

The reduction in strength gives an indication of the extent of any damage by water that has occurred. One of the major criticisms which may be leveled at most of this immersion mechanical test is that, although much work has been carried out in laboratory, little is known about correlation between the test and the actually road performance of the mixtures which are tested. With some of the materials which have been examined by means of these tests, it is even doubtful whether an important practical problem really exists.

2. Explain the desirable properties of bituminous mixes. Mention the different types of bituminous mixes.

Desirable properties

1. Resistance to permanent deformation: The mix should not distort or be displaced when subjected to traffic loads. The resistance to permanent deformation is more important at high temperatures.

2. Fatigue resistance: the mix should not crack when subjected to repeated loads over a period of time.

3. Resistance to low temperature cracking. This mix property is important in cold regions.

4. Durability: the mix should contain sufficient asphalt cement to ensure an adequate film thickness around the aggregate particles. The compacted mix should not have very high

air voids, which accelerates the aging process.
5. Resistance to moisture-induced damage.
6. Skid resistance.
7. Workability: the mix must be capable of being placed and compacted with reasonable effort.
8. Low noise and good drainage properties: If the mix is to be used for the surface (wearing) layer of the pavement structure.

3. Write in detail various methods of Improving Adhesion.

Methods of Improving Adhesion
1) Binder of high viscosity resists stripping more readily than those of low viscosity & hence there is an advantage that the viscosity of the binder should be as high as possible.
2) It is usually necessary to compromise between the lower viscosity needed to give the best initial coating on the aggregate & the higher viscosity desirable to give better protection against stripping.
3) Addition of filler to a mixture increases the viscosity of the binder & hence it will control the rate of stripping.
4) There are certain fillers, hydrated lime & portland cement which when added to bituminous mixture in 1 to 2% weight of total mix will reduce or even completely prevent stripping.
5) Chemically active fillers are also used in the mixing of cold & wet aggregate with bituminous binders.
6) Organic acids present in binders react with filler to form calcium naphthanete or calcium phenate to improve adhesion.
7) Addition of upto 10% of road tar to bitumen improves adhesion in some coated macadam wearing courses.
8) By adding surface-active chemicals to the binder, it has been claimed that some soaps of metals (Ca, Pb, Fe) may improve adhesion.
9) Additives which show cationic surface activity such as cetyl pyridinium bromide & cetyl trimethyl ammonium bromide increases the adhesive bond.
10) Powerful agents like organic amines which have high molecular weight are sprinkled on the surface dressing to increase adhesion.

4. (a) Briefly explain the various tests to be conducted on Cutbacks.

Tests for Cut-Back Bitumen:
1. VISCOSITY
This is a standard test as specified in IS:1206-1978 Part-I. For Cut back Bitumen, a standard tar viscometer (STV) of 4 mm diameter orifice is used. The grade of Cut-back bitumen is designated by its viscosity value.
2. FLASH POINT
This standard test is specified in IS : 1209-1978. For Cut back Bitumens, flash Point in ° C is determined by Pensky Martens closed cup apparatus. The value signifies the safe temperature to which cut-back bitumen can be heated.
3. DISTILLATION
This is a standard test specified in IS:1213-1978. In this test volatile constituents Cut back bitumen are separated between different specified temperature ranges, from which the type of cut back bitumen can be identified. The type and quantity of distillate controls the curing time of cut back bitumen. For example, cut back bitumen RC-3 obtained by

blending paving bitumen 80/100 with about 16 percent by weight of naphtha type distillate requires approximately 12 hours of curing time. A cut back bitumen is taken as cured when the float value at 50° C is more than 120 seconds. The details of float test are given in IS: 1210-1978. Residue obtained from the distillation test is tested for penetration and ductility to determine the nature of base bitumen used in preparation of cut-back bitumen

(B) List the various tests to be conducted on Emulsions.

A) Residue on sieving
b) Stability to mixing with coarse-graded aggregate
c) Stability to mixing with cement
d) Water content
e) Viscosity
f) Coagulation at low temperature
g) Sedimentation
h) Stability on long-period storage

5. (a) Write short notes on types of Cutbacks.

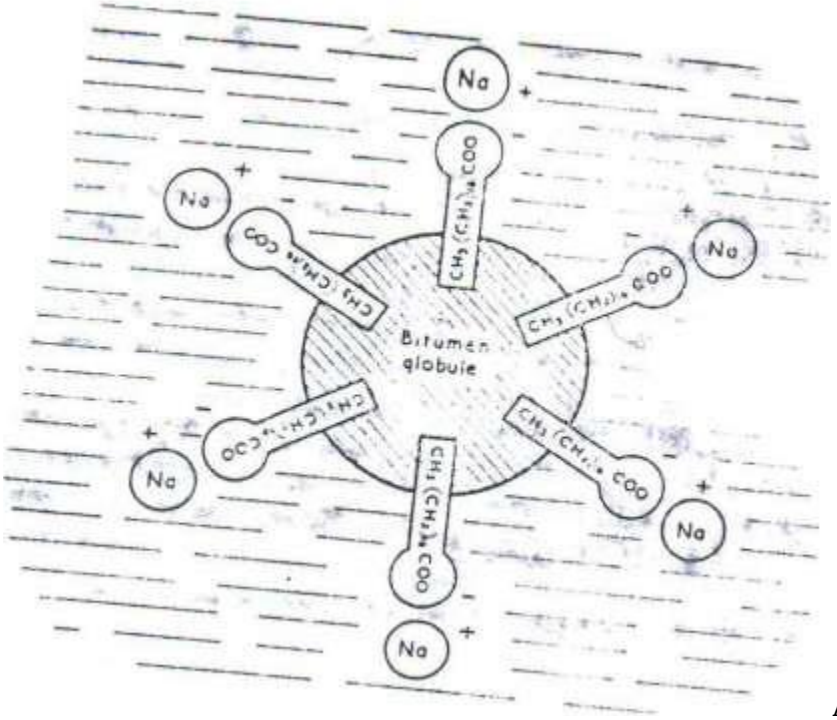
Types of Cutback Bitumen and Uses
Cutback bitumen is available in three types, namely:
a) Rapid Curing (RC)
b) Medium Curing (MC)
c) Slow Curing (SC)

This classification is based on the rate of curing or hardening after the application.
Rapid Curing Cutbacks (RC)
These are bitumens, fluxed or cutbacks with a petroleum distillate such as naphtha or gasoline, which will rapidly evaporate after using in construction, leaving the bitumen binder. The grade of the RC cutback is governed by the proportion of the solvent used. The penetration value of residue from distillation upto 360°C of RC cutback bitumen 80 to 120.
Medium Curing Cutbacks (MC)
This bitumen fluxed to greater fluidity by blending with a intermediate boiling-point solvent like kerosene or light diesel oil. MC cutbacks evaporate relatively at slow rate because the kerosene-range solvents will not evaporate rapidly as the gasoline-range solvents used in the manufacture of RC cutbacks.
MC products have good wetting properties and so satisfactory coating of fine grain aggregate and sandy soils is possible.
Slow Curing Cutbacks (SC)
These are obtained either by blending bitumen with high-boiling-point gas, oil or by controlling the rate of flow and temperature of the crude during the first cycle of refining. SC cutbacks or wood soils hardens or set way slowly as it is a semi volatile material.

(b) Write short notes on cationic and anionic emulsions with neat sketch.

Anionic Emulsifiers
It is characterised by having a large organic anion forming a salt with an alkali. A typical example of sodium stearate CH3 (CH2)16COONa. When dissolved in water, this dissociates into the (negative) stearate anion CH3(CH2)16COO – and the (positive) sodium cation Na+. The long-chain fatty-acid stearate anion is soluble in bitumen, the carboxylic group (COO-)

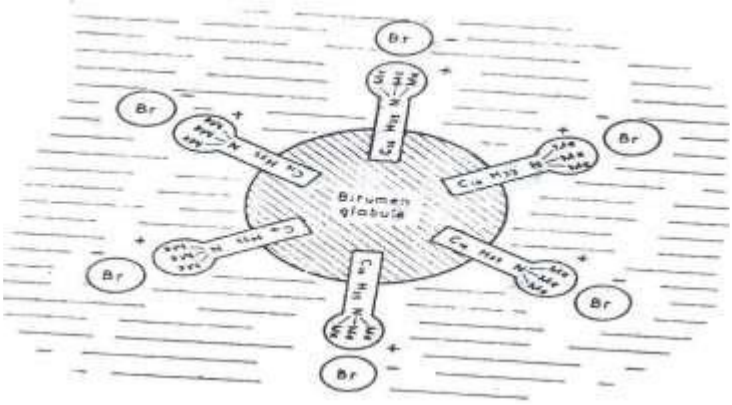
which carries the negative charge being the least soluble part. Each bitumen globule is surrounded by stearate ions with negative charge on the surface and it becomes much more difficult for the globules to coalesce because all have surface negative charges and so tend to repel each other.



Anionic Emulsifier

Cationic Emulsifiers

These are compounds in which it is the cation which is the large organic fraction soluble in bitumen. Typical example is cetyl trimethyl-ammonium bromide C16H33(CH3)3NBr dissociates in water into the (positive) cetyl trimethyl-ammonium cation and the (negative) bromine anion Br-. The cation is soluble in bitumen and when this compound is present in a system of globules of bitumen in water is established, so that each globule of bitumen is surrounded by a positively charged layer.



Cationic Emulsifiers

6. With a neat sketch explain the process of preparation of Emulsion.

Preparation of Emulsion

Materials

Almost all grades of bitumen can be emulsified, from hard penetration grades to softer grades. Harder grades of bitumen are used for industrial purposes.

Methods of Making Road Emulsion

a) Colloid mill method
b) High-speed mixer method
The main difference between the methods is that with the colloid mill the emulsion is produced continuously where as with the high-speed mixer a number of separate batches are produced.

a) Colloid Mill Method

The colloid millconsist of a high-speed rotor which revolves in a stator, the clearance between the rotor and the stator being approximately 15 to 20 thousands of an inch.
A hot solution of the emulsifiers in water and the heated bitumen are fed separately at a constant rate into the machine in the appropriate constant proportions so that an emulsion of uniform binder content is continuously produced. It has been shown that the degree of hardness of the water used has an influence on the degree of dispersion and water-softening plants may need to be installed in areas of very hard water. Road emulsions can be continuously produced in colloid mills at rates of up to 2500 gallons per hour.

b) High-Speed Mixer Method

This method is not widely used because it is a batch process and therefore more labour is required. The procedure is to run appropriate amount of water at hust below boiling point into a 200 or 300 gallon mixer, the diameter of which is equal to depth of liquid it is proposed to mix. The mixer is fitted with a high speed propeller type. Stirrer mounted off-centre to avoid the production of a vortex. Alkali is added to the water in the mixer and bitumen at about 100°C is slowly run in with continous stirring.
Dispersions obtained by this method are not so uniform as those obtained in a colloidal mill. After emulsification by either method, the material is pumped into storage tanks where it is allowed to cool.