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Internal Assessment Test 2 – December 2021 (**SOLUTION**)

Sub:	Pavement Materials and Construction					SubCode:	18CV733	Branch:	CIVIL
Date:	20.12.2021	Duration:	90 mins	Max Marks:	50	Sem/Sec:	VII		OBE

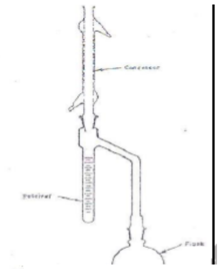
Answer any five questions.
Provide neat sketches wherever necessary

MARKS | CO | RBT

41 — Explain the different tests conducted on bituminous emulsions. [10] CO1 L2

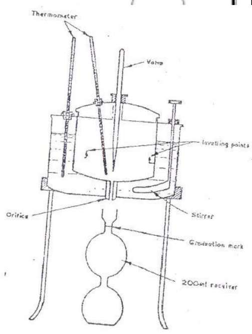
1. Determination of Water Content
2. Measurement of Viscosity
3. Determination of Residue on Sieving
4. Coagulation on storage
5. Long-period storage stability
6. Coagulation at Low Temperature
7. Sedimentation

Determination of Water Content



Take approximately about 100 gms of the sample and pour it into the flask.
Add 100ml of solvent(petroleum).
Attach the flask to the Dean and Stark condensing and collecting system.
Heat the flask at such a rate that the condensate falls from the end of the condenser at a rate of two to five drops per second.
The organic liquid distils into the receiver, carrying with it, water which then separates into lower layer. The excess carrier liquid over flows into the flask.

Measurement of Viscosity



It is first calibrated by filling to the level with distilled water which is adjusted to 20°C by the surrounding water bath.
The time in seconds for 50 ml to run out is recorded.
The viscometer is dried and the test is repeated using emulsion.
The viscosity in Engler degrees is the ratio of the times of flow for emulsion and water.
the ratio obtained by dividing the time of flow, in s, of 50 mL of material using an Engler viscosimeter at a selected temperature by a factor representing the time of flow, in s, for an equal volume of water at 25°C.

Determination of Residue on Sieving

Binder present in a bituminous road emulsion in particles large enough to be retained on a gauge of specified mesh.
Emulsions must not give more than 0.25 g of residue per 100 ml of emulsion when passed through appropriate sieve.
The appropriate sieve is washed, dried, weighed and moistened.
100 ml of emulsion are poured through and the sieve is washed with distilled water.
After drying in a vacuum desiccator, the residue is weighed.

Coagulation on storage

Indicates the tendency of the particles of binder in an emulsion to agglomerate when the emulsion is stored or transported in ordinary commercial containers.
Not more than 0.1 g of coagulant per 100 ml of emulsion should be produced under the conditions of test.

100 ml of sieved emulsion are allowed to stand for 7 days in a stoppered measuring cylinder.
At the end of this period the emulsion is again sieved and the residue weighed after washing and drying.
The weight of residue is reported as coagulated binder per 100 ml of emulsion.

Coagulation at Low Temperature

Indicates if any coagulation of the binder occurs on exposure to low temperatures.
This emulsion is first sieved and preheated to 60°C.
it is then cooled in a series of baths to a temperature of -3° to -4°C.
Remain in quiescent for 30 minutes.
The temperature of the emulsion is allowed to regain air-temperature
when the emulsion is sieved if any coagulated binder is retained, the emulsion fails the test.

Long-period storage stability

Indicates the tendency of the binder in a bituminous road emulsion stored in drums to separate in a form which cannot be redispersed by agitation.
An emulsion should not possess more than 2% of water content difference between before and after storage.
A drum of emulsion is selected and the water content is determined by Dean and Stark method.
The emulsion is transferred to a clean drum leaving 5% air space.
The drum is sealed and left for 3 months at temperature range 5 to 30°C.
At the end of storage period, the test portion is sieved and the water content determined.
The difference between the water content of the emulsion before and after storage is reported as storage stability.

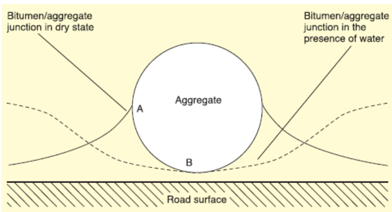
Sedimentation

May occur when a drum of emulsion is left standing before use.
10 g of bitumen emulsion is weighed into a glass tube.
Then centrifuged for five minutes to sediment the emulsion.
30 ml of 1 % soft soap is added and tube is stoppered.
The tube is then rotated end-over-end at one complete inversion per second.
after each five turns the tube is allowed to drain towards the stopper for ten seconds to observe if any sediment remains.
The number of inversions until the sediment disperses is noted and should not be less than 50 for the emulsion.

2 Explain the mechanism of adhesion failure

Failure of the aggregate/bitumen bond is commonly referred to as 'stripping'. The different mechanisms that cause adhesion failure are as follows:

Displacement: If water is introduced at a bitumen/aggregate interface then consideration of the surface energies that are involved shows that the bitumen will retract along the surface of the aggregate. As shown in Figure below, when in contact with water, the equilibrium point at A shifts and the new interface moves or retracts over the surface to point B.

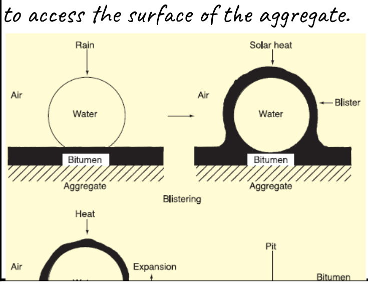


1 Retraction of the bitumen/water interface in the presence of water[1]

Detachment: Detachment occurs when a thin film of water or dust separates the bitumen and aggregate with no obvious break in the surface of the bitumen film being apparent. Although the bitumen film completely encapsulates the aggregate particle, no adhesive bond exists and the bitumen can easily be peeled from the aggregate surface.

Film rupture: At sharp edges or asperities on the aggregate surface where the bitumen film is thinnest, water can penetrate through the film to reach the surface of the aggregate. This movement of water to the aggregate surface may occur with the water in either a vapour or liquid form. Once this process has started, it is possible for the water to spread between the bitumen and aggregate surface to produce a detached film of bitumen.

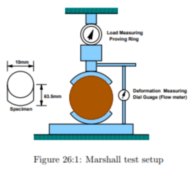
Blistering and pitting: If the temperature of the bitumen in a pavement increases, the viscosity of the bitumen will reduce. If this is associated with a recent rainfall, the bitumen may creep up the edges of water droplets to form a blister, as shown. If the temperature is increased, the blister will expand, leaving a hollow or a pit which may allow water to access the surface of the aggregate.



Hydraulic scouring: When vehicle passes a saturated pavement, tyre sucks up this water, thereby inducing a compression tension cycle in these surface voids, which may result in disbonding of the bitumen from the aggregate. Suspended dust and silt in the water can act as an abrasive and can accelerate disbonding.

Pore pressure: This type of disbonding mechanism is most important in open or

[10] CO1 L2

	poorly compacted mixtures where it is possible for water to be trapped as the material is compacted by traffic. Once the material becomes effectively impermeable, subsequent trafficking induces a pore water pressure which can lead to loss of bond. Chemical disbanding: The presence of the water causes the aggregate surface to exhibit a negative surface charge against a slightly negatively charged bitumen. This results in two negatively charged surfaces in contact and repulsion is the result. As more water is attracted to the aggregate surface, disbonding of the bitumen film will finally occur.			
3	Explain the constituents of a bituminous mix. List and explain the desirable properties of a bituminous mix. Constituents are Coarse aggregates: ● ·offer compressive and shear strength ● ·shows good interlocking properties. ● ·E.g.: Granite ·Fine aggregates: ● ·Fills the voids in the coarse aggregate ● ·stiffens the binder. ● ·E.g. Sand, Rock dust ·Filler: ● ·Fills the voids, ● ·stiffens the binder ● ·offers permeability. ● ·E.g. Rock dust, cement, lime ·Binder: ● ·Fills the voids, ● ·cause particle adhesion ● ·offers impermeability. ● ·E.g. Bitumen, Asphalt, Tar Desirable properties ● Adequate stability of the mix to withstand stresses and deformations due to its repeated application of wheel loads. ● Adequate flexibility to withstand fatigue effects (development of cracks) during service life of the pavement. ● Adequate resistance to permanent deformation such as rutting due to movement of heavy wheel loads during hot weather ● Possess adequate resistance to low temperature cracking under traffic movement ● Durability to sustain the adverse weather and repeated traffic loads. ● Possess sufficient air voids to prevent bleeding of the binder ● Possess adequate resistance against moisture induced damages ● Should possess adequate skid resistance even after continued traffic movements ● Hot mix asphalt should have adequate workability of the mix	[10]	CO2	L2
4	Explain the procedure of determining the optimum bitumen content, for a bituminous mix, by the Marshall test. Stability of the mix is defined as a maximum load carried by a compacted specimen at a standard test temperature of 60℃.Flow is measured as the deformation in units of 0.25 mm between no load and maximum load carried by the specimen during stability test.Optimum binder content for the aggregate mix type and traffic intensity is obtained. Apparatus:- a) Mould assembly: cylindrical mould of 10.16cm diameter and 6.35 cm height, with a base plate and collar. b) Sample extractor c) Compaction pedestal and hammer, weight 4.54 kg with 45.7 cm height of fall. d) Proving ring  Figure 26:1: Marshall test setup	[10]	CO2	L2

	e) Breaking head, to apply a load on its periphery perpendicular to its axis in a loading machine of 5 tons capacity at a rate of 5 cm per minute. f) Loading machine g) Flow meter (dial gauge) Procedure •Select the aggregate gradation from the specified ranges in the table. (IRC or MoRTH) •Take approximately 1200g of aggregate and filler, if any, and heat to a temperature of 175 to 190℃. •Heat the compaction mould assembly and the rammer to a temperature of 138 to 149° C. •Heat the given bitumen to a temperature of 121 to 145℃. •Add the required quantity of trial bitumen content (say 3.5 % by weight of mineral aggregate) and thoroughly mix using a trowel, maintaining a mixing temperature of 154 to 160° C. •Keep the pre-heated mould and collar on the compaction pedestal. •Transfer the mix in the pre-heated mould and compact it 75times using the specified rammer. Turn the mould, and give 75 blows on other side as well. •Repeat the procedure with specimens having other trial bitumen contents. •Allow the specimens to cool in air for a few hours. •Now extract the specimens from the moulds using the sample extractor. •Measure the diameter and mean height of the specimens. Find the weight of specimens in air •Keep the specimens in a water bath maintained at a temperature of 60° C for about 30 to 40 minutes. •Take the weight of the specimen in water. •Keep the specimen in the breaking head assembly in the Marshall apparatus. •Set the proving ring dial and flow dial to zero. •Load the specimen until it fails and record the load applied and flow readings at failure. •Repeat the process for other specimens. Results •Marshall Stability of given mix at bitumen content -------- % = ------------- •Optimum bitumen content for the given mix = -------------- %			

5	A bituminous concrete mix is prepared with aggregates A,B and C in the proportion A:B:C = 40:50:10. The respective specific gravity of A, B and C and bitumen are 2.7, 2.8, 3.0 and 1.02. The bitumen content by weight of aggregate is 5%. Determine the maximum theoretical specific gravity, percentage air voids, voids in mineral aggregates, voids filled with bitumen given that the specimen weighs 1251.5g in air and 720.6g in water. Specific gravity of the mix = $G_m = \frac{1251.5}{1251.5-720.6} = 2.36$ Mass of aggregate in the mix = $\frac{1251.5}{1+0.05} = 1191.9\ g$ Mass of A = $\frac{40\times1191.9}{100} = 476.76\ g$ Mass of B = $\frac{50\times1191.9}{100} = 595.95\ g$ Mass of C = $\frac{10\times1191.9}{100} = 119.19\ g$ Mass of bitumen =1251.5-1191.9 = 59.6 g Theoretical specific gravity = $G_t = \frac{1251.5}{\frac{476.76}{2.7}+\frac{595.95}{2.8}+\frac{119.19}{3}+\frac{59.6}{1.02}} = 2.57$	[10]	CO2	L3

Theoretical density = $G_t \times 1 = 2.57\ g/cc$

(ii) % air voids in the total mix

$$V_v = \frac{G_t - G_m}{G_t} = \frac{2.57-2.36}{2.57} = 8.17\%$$

(iii) % volume of bitumen

$$V_b = \frac{\frac{59.6}{1.02}}{\frac{1251.5}{2.36}} = 11.02\%$$

(iv) Voids in mineral aggregate, VMA = 8.17+11.02=19.19%

(v) Voids filled bitumen VFB = V_b*100 / VMA = 57.4 %

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6 Explain with sketches, the working principle of Power shovel, Drag line and Clamshell. Discuss its applications. [10] CO3 L2

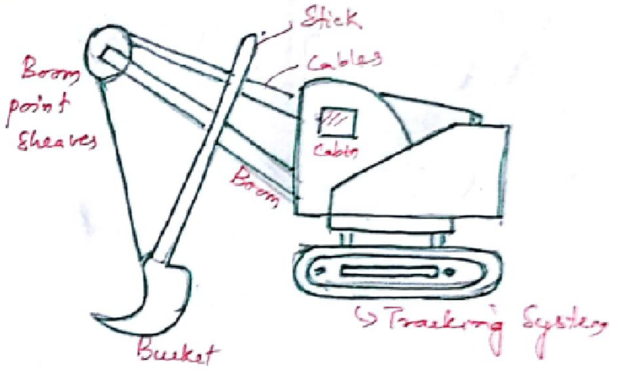
Power Shovel (Dipper Shovel).

* used for digging hard rock in quarries or ore in mines
* used for digging, above the machine base level
* Faster and accurate digging & dumping cycle.
* Performs upward digging action, excavating and filling the bucket as it climbs.

Parts:-

1) Boom (2) Dipper stick (3) Bucket.

Fig is shown below



Mechanism:-

Dipper stick moves back & froth on a shipper drum through a guide system. Shipper drum is mounted on shipper shaft which is passing through the boom and

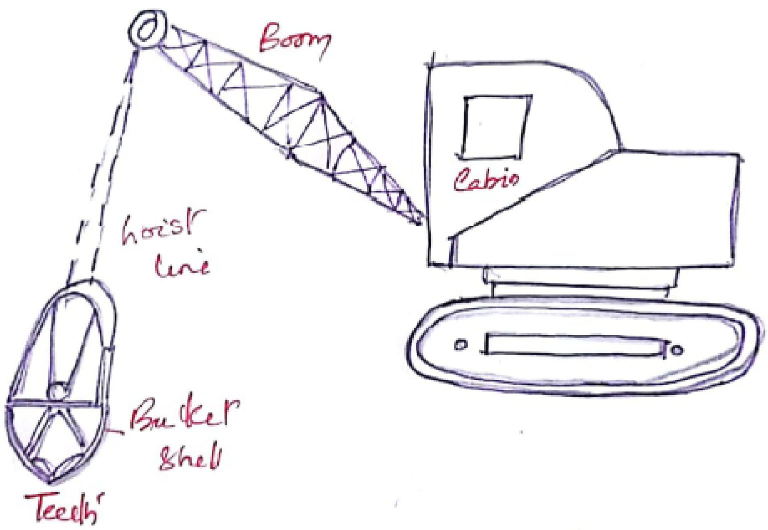
Supported at the ends. Shipper drum is mounted on shaft and the drum is rotated by pulling the cable.

Operation :-

* Bucket is brought down by moving the stick on a vertical plane
* Bucket is moved forward & backward by applying brake and clutch.
* Once the bucket is filled, the machine can be swung around for dumping.
* To empty the bucket, the door is opened by unlatching it through trip arrangement.

Clam shell

* Has the characteristics of drag line & crane in common
* Digging is like a dragline and dumping is like a crane
* Useful for spot dumping of material in a confined space in a vertical plane
* Can be used for handling soft materials only.
* Not very efficient and slow operation.
* For digging trenches
* For charging materials in a bin / stock pile.
* Accurate dumping



Since the bucket is like a clam fish and has hinged double shell, it is named as Clam shell.

For digging, bucket is lowered with shells open over the surface to be dugged till it makes a good contact with it and then it is closed.

The bucket after filling is hoisted and swing to the position where dumping is done and then the contents are dropped.