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Internal Assessment Test 1 –November 2021

Sub:	PAVEMENT MATERIALS AND CONSTRUCTION					Sub Code :	18CV733	Branch:	CIVIL
Date:	12.11.2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	7		OBE

(Answer any 5 full questions). Assume any missing data suitably.
Provide neat sketches wherever necessary

		MARKS	CO	RBT
1.	List all the tests conducted on aggregates. Explain aggregate crushing test in detail.	[10]	CO1	L2
2.	(a) What are the differences between bitumen and tar?	[06]	CO1	L1
	(b) Explain the desirable properties of bitumen.	[04]	CO1	L2
3.	(a) Write a note on aggregate blending to meet the specified gradation.	[06]	CO1	L2
	(b) Briefly explain the chemical constitution of bitumen.	[04]	CO1	L2
4.	(a) Explain the manufacturing process of bitumen with a neat sketch.	[06]	CO1	L2
	(b) Explain cationic and anionic emulsions.	[04]	CO1	L2
5.	(a) Explain the basic classification of aggregates.	[06]	CO1	L2
	(b) Explain any 4 properties of emulsion.	[04]	CO1	L2
6.	Explain Rothfutch's method of desired gradation.	[10]	CO1	L2

Course Instructor Signature/s CCI Signature HOD

ANSWER KEY

Q1. List all the tests conducted on aggregates. Explain aggregate crushing test in detail.

- Aggregate impact test.
- Los Angeles Abrasion Test
- Aggregate Crushing Test
- Soundness/ durability/ accelerated weathering test
- Shape test- Flakiness index, Elongation index and Angularity index
- Specific gravity test
- Water absorption test
- Bitumen adhesion test/ Stripping test
- Polished stone value test or resistance to getting smooth or polished Accelerated.

Aggregate Crushing Test

✓ The aggregate crushing value provides a relative measure of resistance to crushing under gradually applied crushing load.

✓ The test consists of subjecting the specimen of aggregate in standard mould to a compression test under standard load conditions.

✓ Dry aggregates passing through 12.5 mm sieves and retained 10 mm sieves are filled in a cylindrical measure in three layers.

✓ Each layer is tampered 25 times with at standard tamping rod.

✓ The test sample is weighed and placed in the test cylinder in three layers each layer being tampered again.

✓ The specimen is subjected to a compressive load of 40 tonnes gradually applied at the rate of 4 tonnes per minute.

✓ Then crushed aggregates are then sieved through 2.36 mm sieve and weight of passing material (W2) is expressed as percentage of the weight of the total sample (W1) which is the aggregate crushing value.

✓ Aggregate Crushing value= $(W_1/W_2)\times 100$

Q2.(a) What are the differences between bitumen and tar?

SL NO:	Bitumen	Tar
1	Bitumen is found in black to brown in colour.	Tar is usually found in brown colour.
2	Bitumen is obtained from fractional distillation of crude oil.	Tar is obtained by destructive distillation of coal or wood.
3	Bitumen is soluble in carbon disulphide and carbon tetra chloride.	Tar is soluble in toluene.
4	Molecular weight range for road bitumen is 400 to 5000.	Molecular weight range for road tar is 150 to 3000.
5	Bitumen consists of large amount of aromatic hydrocarbon.	Tar consist of large amount of oily matter with lower molecular weight.
6	Bitumen show resistance to coating road aggregate and also does not retain in presence of water.	Tar coats more easily and retain it better in presence of water.
7	Free carbon content is less.	Free carbon content is more.
8	It shows more resistance to weathering action.	It shows less resistance to weathering action.
9	Less temperature susceptibility.	More temperature susceptibility.

Q2(b) Explain the desirable properties of bitumen.

1) Viscosity

The viscosity of the bitumen at the time of mixing and compaction should be adequate. This is achieved by heating the bitumen and aggregate prior to mixing or by use of cutbacks or emulsions of suitable grade.

2) Temperature Susceptibility/Durability

The bituminous material should not be highly temperature susceptible. During the hottest weather of the region the bituminous mix should not become too soft or unstable. During cold weather the mix should not become too hard and brittle, causing cracking. The material should be durable.

3) Adhesion Property

In presence of water the bitumen should not strip off from the aggregate. There has to be adequate affinity and adhesion between the bitumen and aggregate used in the mix.

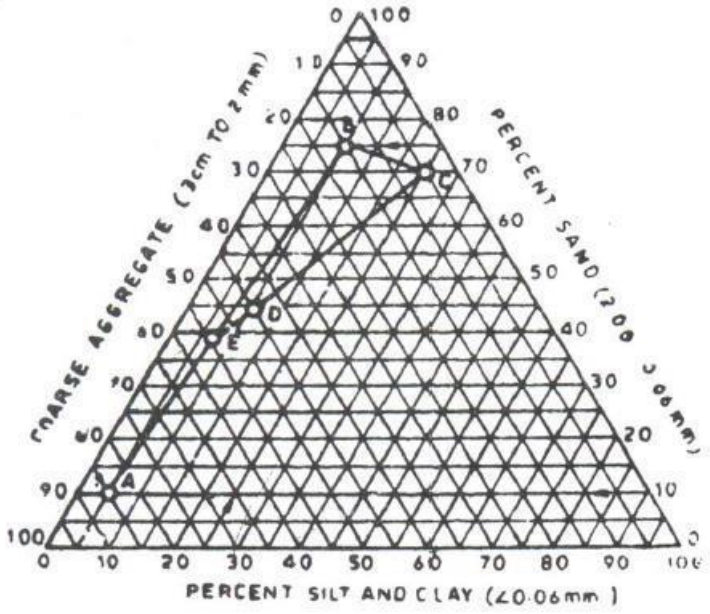
Q3. (a) Write a note on aggregate blending to meet the specified gradation.

Aggregate blending is a method of mixing the aggregates of different sizes to obtain or to satisfy the design gradation.

There are several techniques used to blend the aggregates. The trial method is the one in which the aggregates are blended by several trials to get the design gradation and to meet the required specification.

Two graphical methods in common use for proportioning/blending are:

1) Triangular Chart
   - applicable when three materials are to be mixed together to achieve a desired gradation (for maximum density).
   - The materials may be conveniently divided on a triangular chart as shown in figure.



% coarse aggregate=$((EB \times DC)/(AB \times EC))\times 100$

% Sand=$((AE \times DC)/(AB \times AE))\times 100$

% Fines=$(ED/EC)\times 100$

2) Rothfutch's Method

This method is used when a number of materials have to be mixed together for obtaining appropriate gradation. The gradation may be decided either based upon recommended grain size
distribution charts or by any equation like Fuller's gradation. Fuller's equation is given by:

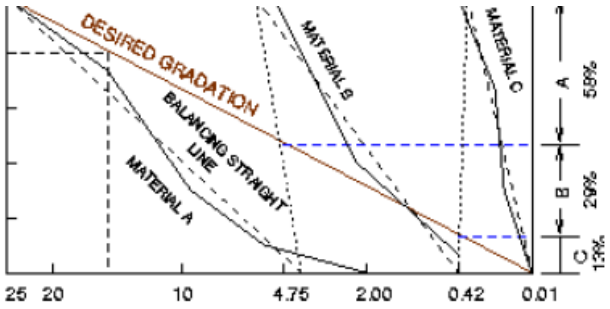
$\mathbf{P=100(}\boldsymbol{d/D}\mathbf{)}\boldsymbol{n}$

Where D= diameter of largest particle, mm

P= percent finer than diameter d (mm) in the material

n= gradation index, which have values ranging from 0.5 to 0.3 depending upon the shape.

It is done to proportionate materials for Marshall Mix design. I S sieves of sizes 63, 50, 40, 31.5,25, 20, 16, 12.5, 10, and 6.3mm are required.



Q3(b) Briefly explain the chemical constitution of bitumen.

- ✓ Bitumen although formed from distillation process causes some changes which is closely related in chemical nature to its primary source i.e., the crude petroleum oil.

✓ Bitumen is completely soluble in carbon-di-sulphide but most of them divide the bitumen soluble in carbon-di-sulphide into 3 fractions:

a) Carbenes: fraction insoluble in carbon tetrachloride.

b) Asphaltenes: fraction insoluble in light aliphatic hydrocarbon solvent such as petroleum ether.

c) Maltenes: fraction soluble in light aliphatic hydrocarbon solvent

✓ The molecular weight of asphaltene fraction is estimated between 1800 and 1,40,000 and maltenes have molecular weight between 370 and 710.

✓ The hydrocarbons in petroleum are of four basic forms:

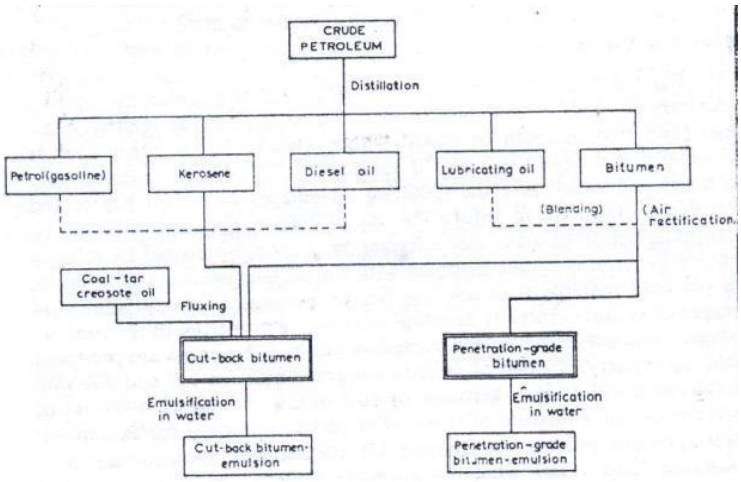
a) Saturated aliphatic groups or paraffins

b) Naphthenic groups or cycloparaffins

c) Aromatic ring compounds

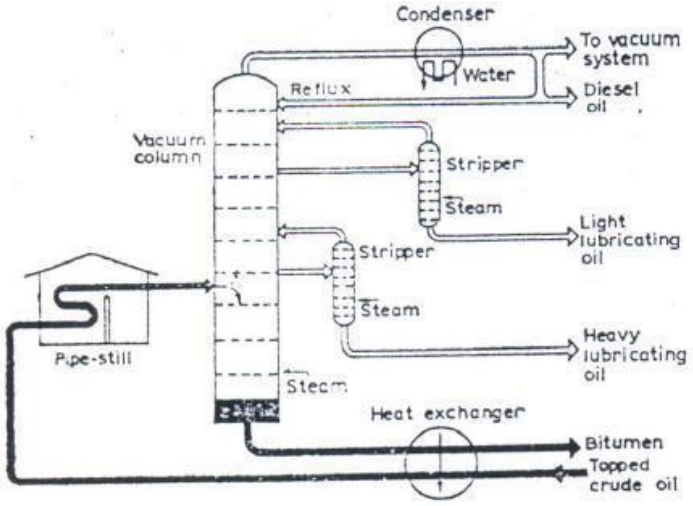
d) Aliphatic groups with olefin double bonds

4.(a) Explain the manufacturing process of bitumen with a neat sketch.



a) Distillation of Petroleum

- ✓ Bitumen is produced from selected crude oils by a process of concentration by distillation.
- ✓ The distillate is obtained in the desired boiling point ranges by condensation in a fractionating column.
- ✓ It is first to heat the crude oil to a temperature lower than 350°C under atmospheric pressure to drive off light fractions such as gasoline, kerosene and gas oil.
- ✓ Further heating above 400°C is necessary to drive off heavier oils.
- ✓ Refining of the topped crude is carried out by use of reduced pressures and steam injection in the fractionating column.
- ✓ The incoming crude is pumped through a continuous pipe-still similar to that used in tar-distillation plants, where it is raised to desired temperature (between 200 and 400° C)
- ✓ It is then injected into a fractionating column where at the reduced pressure volatile components flash into vapours.
- ✓ The vapours are condensed into fractions of decreasing boiling point by condensation at points at higher levels in the fractionating column.
- ✓ A flow diagram representing the distillation of topped oil in a modern refinery is given in figure below:



b) Air-Rectification of Refinery Bitumen

Bitumen produced by straight steam-refining from crude oils may be deficient in the components of high molecular weight which are insoluble in heptanes, asphaltenes fractions.

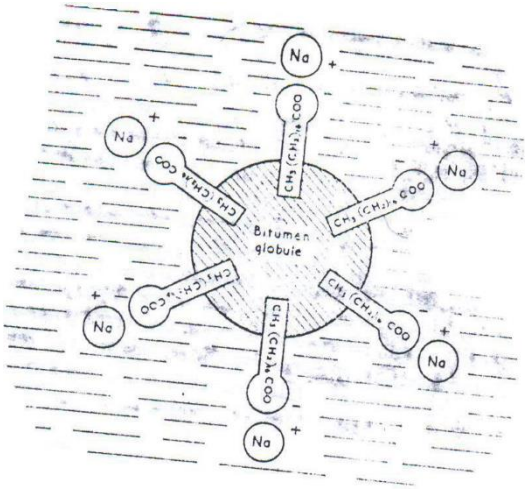
It is common practice to increase the asphaltene content by oxidation of the hot straight-run bitumen by a current of air blown through it.

These are bitumen of high softening point produced by an oxidation by air-blowing at high temperatures.

Q4(b) Explain cationic and anionic emulsions.

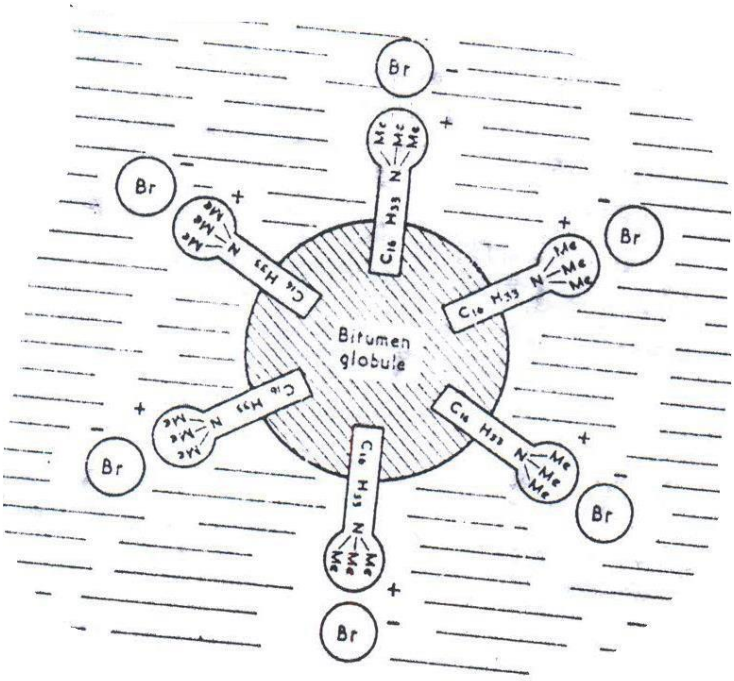
Anionic Emulsifiers(minimum 4 ponts with example)

- ✓ 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.



Cationic Emulsfiers(min 4 points)

- ✓ 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
- ✓ It 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.



Q5.(a) Explain the basic classification of aggregates.

Based on Origin

1. Igneous Rocks: formed through the cooling and solidification of lava. In the process of solidification, the atoms or molecules are highly organized into a structure known as a crystal (Crystallization). Further igneous rocks are classified as below:

Classification based on grain size:

a) Course (>2mm)

b) Medium (2mm to 0.2mm)

c) Fine (<0.2mm)

Classification based on composition:

a) Acid rocks (>66% silica, light in colour & specific gravity <2.75)

b) Intermediate rocks (55 to 66% silica)

c) Basic rocks (<55% silica, dark in colour & specific gravity >2.75)

2. Sedimentary Rocks: formed by the deposition and subsequent cementation of sediments either on earth's surface or underwater. The agents of denudation such as water, wind, ice, mass movement or glaciers transport the sediments to the place of deposition.

Classification based on predominating mineral:

a) Calcareous rock (chalk, lime stone & dolomite)

b) Siliceous rock (sand stone, flint & chert)

c) Argillaceous (clay & shale)

3. Metamorphic Rocks: arise from the transformation of existing rock types, in a process called metamorphism. Examples of metamorphic rocks are gneiss, slate, marble, schist, and quartzite.

Classification based on grain size:

a) Fine grain size (hornfels & schist)

b) Coarse grain size (gneiss & Granulite)

- ✓ Based on the strength property, the coarse aggregates may be divided as hard aggregates and soft aggregates.
- ✓ For the bearing course of superior pavement types, hard aggregates are preferred to resist the abrading and crushing effects of heavy traffic loads and to resist adverse weather conditions.
- ✓ In the case of low-cost road construction for use in lower layers of pavement structures, soft aggregates can also be used. The soft aggregates include moorum, kankar, laterite, brick aggregates and slag.

Based on sghape and size

Q5(b) Explain any 4 properties of emulsion.

Any 4 of the below

- ✓ Residue on Sieving

Practically all road bitumen and tars are slightly heavier than water and the globules of binder will tend to sediment in emulsion; the rate at which it sediments depends on the size of the particle. Hence percentage of large particles should be controlled and hence is to ensure that not more than 0.25% by weight of emulsion consists of particles greater than 0.006 inch in diameter.

- ✓ Stability to Mixing With Coarse-Graded Aggregate

When mixing bitumen emulsions with coarse aggregates, break down of the emulsion and coating off the aggregates with bitumen should not take place too early in the mixing cycle. Stable emulsions should have sufficient mechanical and chemical stability for all purposes involving mixing with fines and cement.

- ✓ Stability to Mixing With Cement

Stable emulsions should have sufficient mechanical and chemical stability for all purposes involving mixing with aggregates including those containing large proportions of fines. Cement is used as a standard fine aggregate.

- ✓ Water Content

Road emulsions may contain up to 65% of water. It is essential to know this percentage if the quantity of bituminous binder actually used in the surfacing is to be measured accurately. The water content of an emulsion is often varied to suit particular forms of application.

- ✓ Viscosity

It is determined by the proportion of bitumen or tar in the emulsion and by the particle-size distribution. The viscosity of the emulsion should be low enough to spray through conventional jets or to coat stone. It is measured by Engler out flow viscometer.

- ✓ Coagulation at Low Temperature

All emulsions contain water they are affected by extremes of heat and cold. Exposure to temperatures below 0°C will result in freezing and the degree of recovery on thawing depends on type of emulsion.

- ✓ Sedimentation

Some sedimentation may occur when a drum of emulsion is left standing before use; provided however the sediment redisperses on agitation, the emulsion can be used satisfactory.

- ✓ Stability on Long-Period Storage

When stored in drums under normal atmospheric conditions, the emulsion should not separate in a form which cannot be redispersed by agitation.

Q6. Explain Rothfutch's method of desired gradation.

This method is used when a number of materials have to be mixed together for obtaining appropriate gradation. The gradation may be decided either based upon recommended grain size distribution charts or by any equation like Fuller's gradation. Fuller's equation is given by:
$\mathbf{P}=\mathbf{100}(\boldsymbol{d/D})\text{^}\boldsymbol{n}$

Where D= diameter of largest particle, mm

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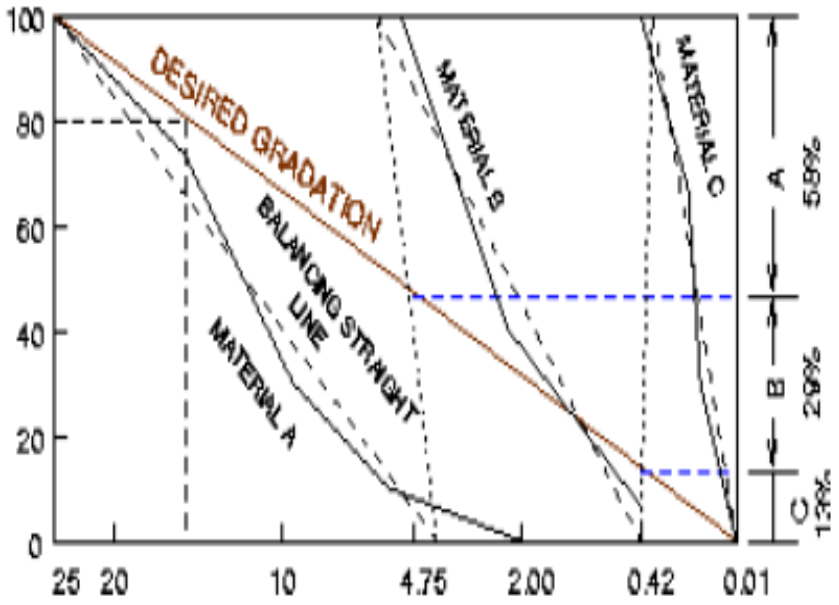
Procedure:

1. On a graph paper when Y-axis represents percent passing and X-axis representing particle size a diagonal line is drawn from point corresponding to 100 percent particles passing i.e maximum particle size passing to a point corresponding to zero percentage passing i.e smallest particle size.
2. For different material say A, B and C sieve analysis has to be done and percentage finer has to be calculated at each range of particle size for all the materials.
3. The balancing straight lines of A, B and C are obtained by allowing only minimum of the areas on the center sides of the balancing lines.
4. The opposite ends of the balancing line of A and B are joined (i.e zero point passing of material A is pointed with 100 percent passing B). Similarly, the opposite ends of the balancing lines of B and C are joined.
5. The points where these lines meet the desired gradation line represent the proportions in which type materials A, B and C are to be mixed. These values may be read from the Y axis by projecting the Points of intersection, as shown in the figure below.

Thus, Proportion of materials A, B and C to be mixed for preparing Marshall mix design test specimen is obtained



Proportioning of materials