CMR
INSTITUTE OF
TECHNOLOGY

Internal Assessment Test 1 – Sep. 2018

Scheme and Solution

Sub:	Pavement Materials and Construction					Sub Code:	10CV763	Branch:	Civil
Date:	10/09/2018	Duration:	90 mins	Max Marks:	50	Sem/Sec:	VII (Parallel Class)		

Q1. List the various tests conducted on road aggregates in order to ascertain its suitability in road construction. Explain the shape tests on aggregates in detail.

(i) **Test for road aggregates:** (2 marks)

1. Crushing test
2. Abrasion test
3. Impact test
4. Soundness test
5. Shape test
6. Specific gravity and water absorption test
7. Bitumen adhesion test

Shape Test (3 + 3 +2 = 7 marks)

Aim

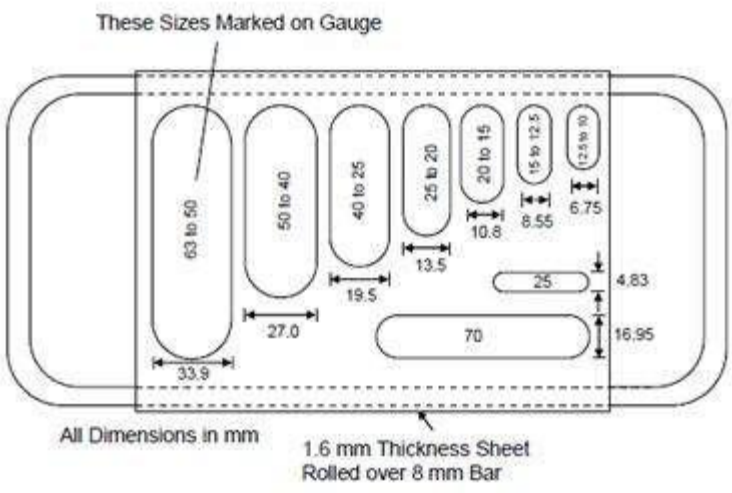
To determine the Flakiness Index, Elongation Index and Angularity Number of the given sample of aggregate.

1. Flakiness Index

The Flakiness index of aggregate is the percentage by weight of particles whose least dimension [thickness] is less than three- fifths [0.6] times of their mean dimension. The test is not applicable to
aggregate size smaller than 6.3 mm

Apparatus

a) Thickness gauge
b) Weighing balance
c) IS Sieves of sizes
63 mm, 50 mm, 40 mm, 31.5 mm,25 mm,20 mm, 16 mm, 12.5 mm, 10 mm and 6.3 mm



Procedure

1. The sieves are arranged such that the largest size sieve (63 mm) is at the top and the smallest size sieve (6.3 mm) is at the bottom.
2. The given aggregate are sieved. A minimum of 200 pieces of each fraction to be tested are taken and weighed = W1 g.
3. In order to separate flaky aggregate, each fraction is then gauged for thickness through the respective opening on the thickness gauge. For example, if the aggregate is from 50 – 40 fraction, it is gauged through the opening of 27.00 mm on the thickness gauge.
4. The flaky aggregate passing the respective openings are collected and accurately weighed = w1 g.
5. The procedure is repeated for other fractions having weights W2, W3, etc. and the flaky aggregate in them having weights w2, w3 respectively are weighed.
6. Then Flakiness Index =

$$\frac{(w1+w2+w3+\text{------})}{(W1+W2+W3+\text{-------})} \times 100$$

= …….. %

Result

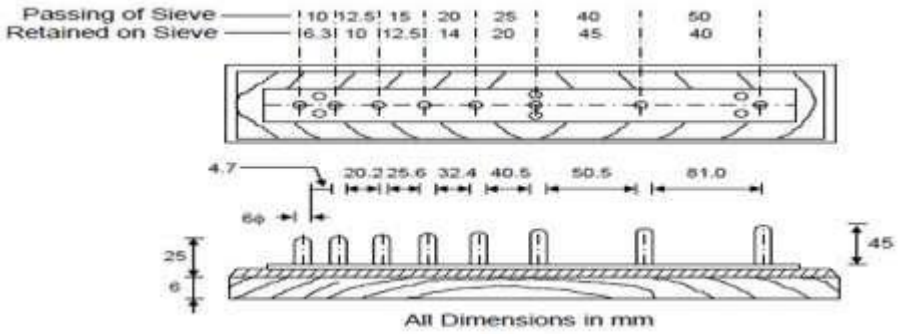
The flakiness Index of the given sample of aggregate is _____

2. Elongation Index

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than one and four fifth times [1. 8] times their mean dimension. The elongation test is not applicable to size smaller than 6.3 mm.

Apparatus

a) Length gauge
b) Weighing balance
c) IS Sieve of size as in flakiness Index test.



Procedure

1. The sample is sieved through the IS sieves specified and a minimum of 200 pieces of each fraction are taken and weighed = W1 g.
2. In order to separate elongated aggregate , each fraction is then gauged individually for length through the respective opening on the length gauge
3. In each fraction, the aggregate retained on the respective opening on the length gauge is collected and weighed =X1 g.
4. The procedure is repeated for other fractions having weights W2, W3, etc, and the weights of elongated aggregate in them X2, X 3 etc, are found.
5. Then

(X1+X2+X3 +----------)

Elongation Index =

x 100 %

(W1+W2+W3+----------)

x 100 = …… %

W

Result

The elongation Index of the given sample of aggregate = _____ %

3. Angularity Number

The angularity number of an aggregate is the amount by which the percentage voids exceeds 33, after being compacted in a prescribed manner. The angularity number is found from the expression (67

- 100 * W / CG, percent). Here the value 67 represents the percentage volume of solids of most rounded gravel, which would have 33 percent voids

Apparatus

a) A metal cylinder closed at one end having 3 litre capacity, diameter and height approximately equal

b) A metal tamping rod, 16 mm in diameter and 600 mm long.

c) Weighing balance

d) IS sieves 25, 20, 16,12.5, 10, 6.3 and 4.75 mm

Procedure

1) The sieves for each fraction (as specified) are arranged such as 25 - 20 mm, etc.
2) The given sample of aggregate is sieved so that sufficient pieces are obtained in each fraction.
3) The empty cylinder is accurately weighed = ‘ a’ g
4) Each aggregate fraction is separately filled in the cylinder in 3 (three) layers tamping each

layer 100 (hundred) times with the rounded end of tamping rod. The excess aggregate are removed.
5) The cylinder along with aggregate is weights = ‘b’ g
6) The aggregate are removed from the cylinder. The cylinder is completely filled with water and after wiping its outer sides it is weighed with water = ‘d’ g
7) Then Angularity number may be calculated from the expression,
Angularity number = 67 - 100 W / CG
Where, W= Mean weight of aggregate in the cylinder
C = Weight of water required to fill the cylinder
G= Average Specific gravity of aggregate

Result

The angularity number of the given sample of aggregate = ……. %

Q2. Explain the desirable properties of aggregates to be used in pavement construction.

(5 *2 = 10 marks)

Strength:

 The aggregates should be strong to withstand the stresses due to traffic wheel load.

 Aggregates used in top layers of pavements I.e. wearing course have to be capable of withstanding high stresses in addition to wear and tear hence should posses resistance to crushing.

Hardness

 The aggregate used in surface course are subjected to constant rubbing or abrasion due to moving traffic.

 They should be hard enough the wear due to abrasive action of traffic.

 Heavy wheel loads can also cause deformation on some types of pavements.

 The mutual rubbing of stones is called attrition which also cause little wear in the aggregates.

Toughness

 Aggregates in pavements are subjected to impact due to moving wheel loads.

 Severe impact like hammering is seen when heavily loaded steel tyred vehicles move on WBM roads.

 Jumping of steel tyred wheels from one stone to another cause severe impact.

 The magnitude of impact increases with the roughness of load surface, speed of the vehicular characteristics.

Durability

 They should be durable and should resist disintegration due to action of weather.

 The property of the stones to withstand adverse action of weather is called soundness.

 The aggregates are subjected to physical and chemical action of rain and ground weather and hence road stones should be sound enough to withstand weathering action.

Shape of aggregates

 Flaky and elongated aggregates will have less strength compared with cubical, angular or rounded particles.

 Rounded aggregates are preferred in cement concrete mix due to better workability where as these materials are not preferred in granular base course, water bound macadam and bitumen construction. In such cases angular particles are used.

 Highly angular flaky and elongated aggregates have more voids in comparison with rounded aggregates.

Adhesion with Bitumen The aggregates used in bituminous pavements should have less affinity with water or else bituminous coating on the aggregate will be stripped off in presence of water.

Q3. Briefly explain the classification of aggregates. Write a note on Rothfutch's method of aggregate blending.

Solution :

(i) Classification based on grain size: (2 marks)

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. Generally 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. A different set of test specifications are adopted for soft aggregates.

(i) Rothfutch's method of proportioning: (8 marks)

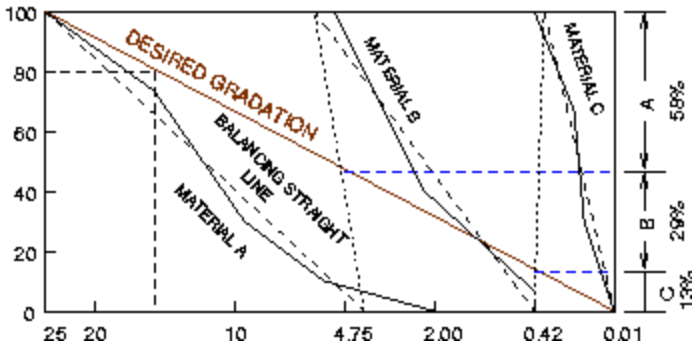
This method is used when a number of materials have to be mixed together for obtaining appropriate gradation. The gradation may be decided either based upon recommended grain size distribution charts or by any equation like Fuller's gradation.

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.

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.



Proportioning of materials

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

(i) 4 (a) What are the differences between bitumen and tar? (5 marks)

Difference 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

(i) 4(b) List the various tests to be conducted on Tar. (10* 0.5 = 5 marks)

The various tests carried out on road tars are:
a) Specific gravity test
b) Viscosity test on standard tar viscometer
c) Equiviscous temperature (EVT)
d) Softening point
e) Softening point of residue
f) Float test
g) Water content
h) Phenols, percent by volume
i) Naphthalene, percent by weight
j) Matter insoluble in toluene, percent by weight
k) Distillation fraction on distillation upto 200°C, 200°C to 270°C and 270°C to 330°C

5 (a) Write short notes on Hydrophobic and Hydrophilic Aggregates.

Hydrophilic and Hydrophobic Aggregates (2* 2.5 = 5 marks)

Most of the road stones have surfaces that are electrically charged. Silica, a common constituent of igneous rocks posses a weak negative charge and hence these have greater attraction with the polar liquid water than with bituminous binders having little polar activity. These aggregates which are electronegative are water-linking and are **hydrophilic**.

Basic aggregates like lime-stones have a dislike for water and greater attraction to bitumen, as they have positive surface charge. These aggregates are called **hydrophobic.**
Type of charge of aggregates used in road plays a vital role in bituminous construction. Bitumen is also available as cationic or positive and anionic or negative and hence a suitable selection may be made depending on aggregates available. Cationic (+) bitumen may be selected for electronegative aggregate and anionic (-) bitumen for electropositive aggregates.

(b) Write short notes on Desirable Properties of bitumen.

Requirements of Bitumen (2 * 1 = 2 marks)
The desirable properties of bitumen depend on the mix type and construction.
a) Mixing: type of materials used, construction method, temperature during mixing, etc.
b) Attainment of desired stability of the mix
c) To maintain the stability under adverse weather conditions
d) To maintain sufficient flexibility and thus avoid cracking of bituminous surface and
e) To have sufficient adhesion with the aggregates in the mix in presence of water

Desirable Properties of Bitumen (3 * 1 = 3 marks)
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
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.

6. With a neat sketch explain the process of manufacture of bitumen.

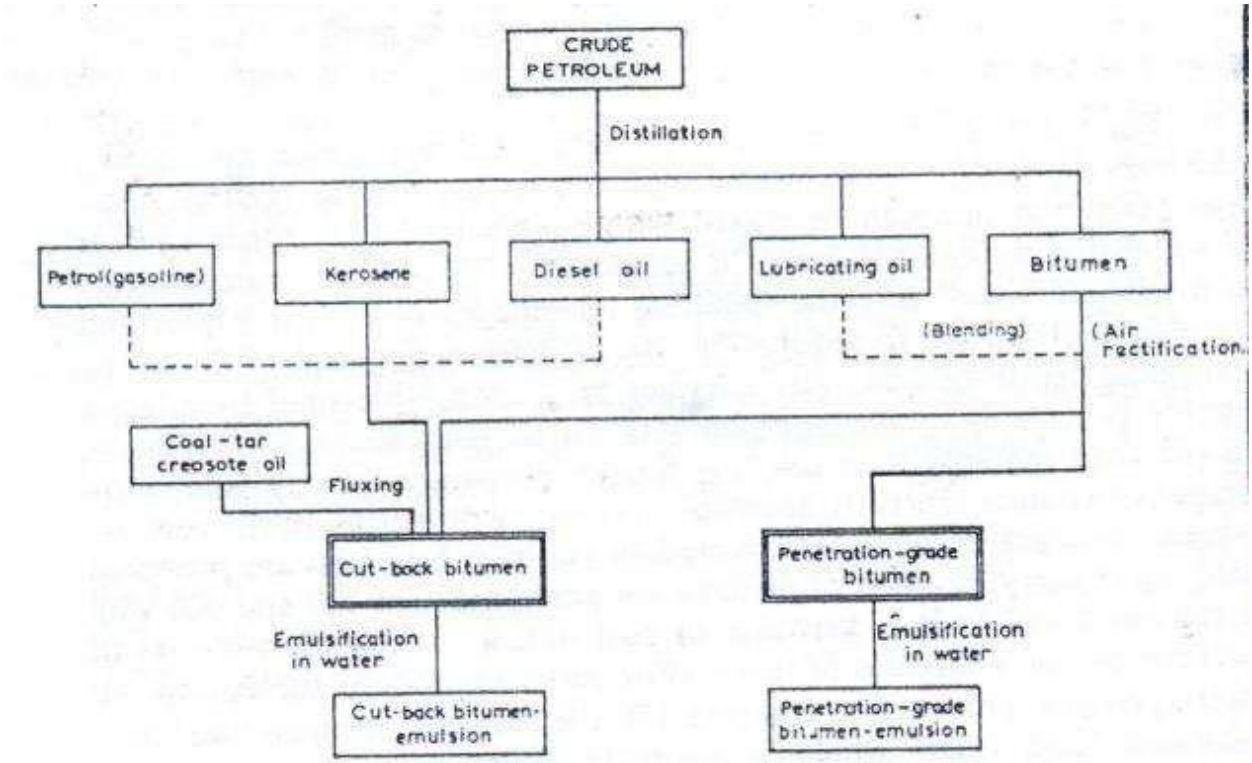
   Flow chart = 5 marks

   Explanation = 5 marks

Preparation of Road Bitumen from Petroleum

The refining of petroleum is most complex procedure producing a tremendous range of products from the simplest hydrocarbon gas methane to the hardest bitumen with constituents of molecular weight of the order of several thousands.

The preparation of different forms of bitumen for road purposes from petroleum is illustrated in the above figure.



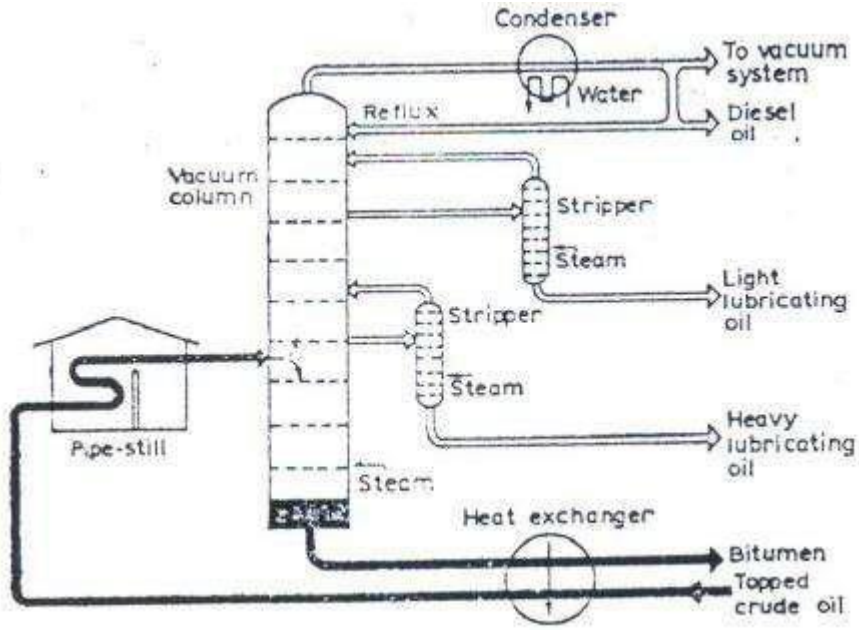
a) Distillation of Petroleum

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 tardistillation
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.
The oxidation is more extensive and the blown bitumens have rubbery qualities required for certain industrial purposes and not used as binders for road aggregates.