UNIT - 2

BITUMEN AND TAR: Origin, preparation, properties and chemical constitution of bituminous road binders; requirements. [4 Hours]

Introduction

Bituminous binders used in pavement construction works include both bitumen and tar. Both bitumen and tar have similar appearance, black in colour though they have different characteristics.

Origin

Naturally occurring deposits of bitumen are formed from the remains of ancient, microscopic algae and other once-living things. When these organisms died, their remains were deposited in the mud on the bottom of the ocean or lake where they lived. Under the heat and pressure of burial deep in the earth, the remains were transformed into materials such as bitumen, kerogen, or petroleum. Deposits at the La Brea Tar Pits are an example. There are structural similarities between bitumens and the organic matter in carbonaceous meteorites. However, detailed studies have shown these materials to be distinct. Asphalt or bitumen can sometimes be confused with "tar", which is a similar black, thermoplastic material produced by the destructive distillation of coal. During the early and mid-20th century when town gas was produced, tar was a readily available product and extensively used as the binder for road aggregates. The addition of tar to macadam roads led to the word tarmac, which is now used in common parlance to refer to road-making materials. However, since the 1970s, when natural gas succeeded town gas, asphalt (bitumen) has completely overtaken the use of tar in these applications.

BITUMEN is a petroleum product obtained by the distillation of petroleum crude.

TAR is a thermoplastic material obtained from the destructive distillation.

The grade of bitumen used for pavement construction work of roads and airfields are called paving grades and used for water proofing of structures and industrial floors etc. are called industrial grades. The paving bitumen available in India is classified into two categories.
1) Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35, A90, etc.

2) Paving bitumen from other sources denoted as S-type and designated as grades S35, S90 etc.

The viscosity of bitumen is reduced some times by a volatile diluents this material is called **Cutback**. The bitumen is suspended in a finely divided condition in an aqueous medium and stabilized with an emulsifier; the material is known as **Emulsion**.

**Difference between Bitumen and Tar**

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

**Bitumen**

The source of road bitumen is either formed from petroleum or by natural processes as a result of geological forces.

**Different forms of bitumen**

**Cutback bitumen**

Normal practice is to heat Bitumen to reduce its viscosity. In some situations preference is given to use liquid binders such as cutback bitumen. In cutback bitumen Suitable solvent is used to lower the
viscosity of the bitumen. From the environmental point of view also cutback bitumen is preferred. The solvent from the bituminous material will evaporate and the bitumen will bind the aggregate. Cutback bitumen is used for cold weather Bituminous road construction and Maintenance. The distillates used For preparation of cutback bitumen are naphtha, kerosene, diesel, oil and furnace oil. There are different types of cutback bitumen Like rapid curing(RC),medium curing(MC), And slow curing(SC).RC is recommended for Surface dressing and patchwork. MC is recommended For premix With less quantity of fine aggregates.SC is used For premix with appreciable quantity of fine aggregates.

**Bitumen Emulsion**

Bitumen emulsion is a liquid product in which bitumen is suspended in a finely divided condition in an aqueous medium and stabilized by suitable material. Normally cationic type emulsions are used in India. The bitumen content in the emulsion is around 60% and the remaining is water. When the emulsion is applied on the road it breaks down resulting in release of water and the mix starts to set. The time of setting depends upon the grade of bitumen. The viscosity of bituminous emulsions can be measured as per IS:8887-1995.Threetypes of bituminous emulsions are available, which are Rapid setting(RS),Medium setting (MS),And Slow setting (SC).Bitumen Emulsions are ideal binders for hill road construction. Where Heating of bitumen or aggregates are difficult. Rapid Setting emulsions are used for surface dressing work. Medium Setting emulsions are preferred for premix jobs and patch repairs work. Slow setting Emulsions are preferred in rainy season.

**Bituminous primers**

In bituminous primer the distillate is absorbed by the road surface on which it is spread. The absorption there for depends on the porosity of the surface. Bitumen primers are use full on the stabilized surfaces and water bound macadam base courses. Bituminous primers are generally prepared on road sites by mixing penetration bitumen with petroleum distillate.
**Modified Bitumen**

Certain additives or blend of additives called as bitumen modifiers can improve properties of Bitumen and bituminous mixes. Bitumen treated with these modifiers is known as modified bitumen. Polymer modified bitumen (PMB)/crumb rubber modified Bitumen (CRMB) should be used only in wearing course depending upon the requirements of extreme climatic variations. The detailed specifications for modified bitumen have been issued by IRC: SP: 53-1999. It must be noted that the performance of PMB and CRMB is dependent on strict Control on Temperature during construction.

**The advantages of using modified bitumen are as follows:**

1. Lower susceptibility to daily and seasonal temperature variations
2. Higher resistance to deformation at high pavement temperature
3. Better age resistance properties
4. Higher fatigue life for mixes
5. Better adhesion between aggregates and binder

**Types**

1) **Rock Asphalt**
   a) It consists of limestone, sand stone naturally impregnated with bitumen.
   b) The mineral matter will be about 90% and bitumen content of 10%.

2) **Lake Asphalt**
   a) Mineral matter will be finely divided and dispersed through the bitumen
   b) The whole mass is capable of flow
c) Type of lake asphalt used in road making in United Kingdom is Trinidad lake asphalt.

d) It is used in flexible road construction and also in rolled asphalt wearing courses.

**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 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:

![Flow Diagram of Bitumen Production]

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.

**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

Aliphatic group normally does not present in road bitumen. The approximate proportions of the other three groups in the molten groups can be obtained from modified Waterman analysis.

Many properties of bitumen, particularly the non-Newtonian flow properties suggest that bitumen is a colloidal system. The colloidal nature of bitumen is due to the presence of asphaltenes in association with high molecular weight material from the maltenes fraction, form a disperse phase. This complex is normally referred as ‘micellar phase’.

On the basis of flow properties, bitumen can be divided into two types, ‘sol’ type, in which there is little interaction between micelles or a ‘gel’ type in which interaction of micelles are
great enough to cause a loose structure formation. Most of the distilled road bitumens are sol
type, blowing leads to gel type structures.

Requirements of Bitumen

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

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.

Tests on bitumen
There are a number of tests to assess the properties of bituminous materials. The following
tests are usually conducted to evaluate different properties of bituminous materials.
1. Penetration test
2. Softening point test
3. Ductility test
4. Viscosity test
5. Specific gravity test
6. Heat stability test
   a. Flash point test
   b. Fire point test
   c. Loss on heating test
7. Solubility test
8. Thin film oven test
9. Float test
10. Water content test

1. Penetration test:
An indirect method of measuring viscosity is the measure of penetration of a standard needle under standard conditions of load, time & temperature. The test measures the hardness or softness of bitumen in terms of penetration expressed in mm/10\textsuperscript{th} of std needle.
Temperature= 25\textdegree C [test to be performed after sample is kept for 1hr in H\textsubscript{2}O bath at this temperature]
Load on needle = 100 g
Time in which penetration is recorded = 5 s
The penetration is measured by a graduated dial.
Bitumen is softens to a poring consistency a depth more than 15mm in the container is poured. The expected penetration sample is cooled in 60 min in air and 60 min in water before testing. The standard needle is positioned to get a penetration value for 5sec and is noted.

The penetration value obtained is represented in 80-100 or 80/100 grade bitumen at standard consistence and it range from 20-225mm.
In cold region bitumen with High penetration value is used.
In warm region low penetration value is used ex. 30/40 grade.
The factors which affect the Penetration test is test temperature, needle size and weight and period of cooling.
1. **Softening point:**

The softening point is the temperature at which the substance attains a particular degree of softening under specified condition of test. A viscosity material like bitumen or tar doesn’t have a well defined softening point. However a std test determines the temperature at which a std ball will pass through a disc of bitumen contained in ring. The test is known as ring & ball test.

A brass ring of internal dia 17.5 mm at top and 15.9 mm at bottom and of depth 6.4mm. The steel ball of 9.5mm dia and 2.5g. Support distance is 25mm between the bottom of the ring and top surface of the bottom plate of support is provided. Glass container of 85mm dia and 120mm depth is used. The bitumen is heated to poring consistency and poured into ring and cooled for half an hour before testing. A brass ring containing the bitumen sample is suspended in H2O or glycerin at given temperature a steel ball is placed on the disc of bitumen. The liquid medium is then heated at a rate of 5°C increase per minute. Metal plate placed at a specified bituminous material touches the bottom at the softening point. With increase in temperature bitumen melts and come down with the weight of ball at particular temperature it touches the bottom plate that point temperature is noted.

The softening point is range between 35 to 75°C.

The liquid water is used for bitumen having softening point less than 80°C and Glycerine is for softening point more than 80°C.

Higher softening point indicates lower temp. susceptibility and in warm climet. The factors which affect the softening points are quality and type of liquid used, weight of ball, distance between bottom of the ring and bottom base plate and rate of temperature.
2. **Ductility test:**
In flexible pavement construction it is important that the binders form ductile thin film around the aggregate. This serves as a satisfactory binder in improving the physical interlocking of the aggregate bitumen mixes. Under traffic loads the bitumen layer is subjected to repeated deformation and recoveries. The binder material which does not possess sufficient ductility would crack and thus provide pervious pavement surface. The test is believed to measure the adhesive property of bitumen and its ability to stretch. The ductility of a binder is an indication of its elasticity & ability to deform under load & return to original condition upon removal of the load. A material which doesn’t possess adequate ductility would crack under a load.

This is unsatisfactory since water can penetrate into the surfacing through there cracks. The property is determined by measuring the distance that a std briquette of bitumen, necked to a cross section of 1 sq-cm will stretch without breaking when elongated at a rate of 5 cm/min at 27°C. The ductility values should be a minimum of 50 as per IS.

The briquette mould is filled with bitumen and cool for 30 min in air and 30 min in water before testing. Then it is fixed to expanding machine assembly which stretches the bitumen at a rate of 5cm/min and expands till to break and the point is noted by scale.

The factors which affect the ductility is pouring and test temperature, dimension of briquette mould, rate of pulling and period of cooling.

3. **Viscosity Test:**
Viscosity is the property of a fluid that determines the resistance offered by the fluid to a shearing force under laminar flow conditions, it is thus the opposite of fluidity.
The determination of viscosity is generally done by efflux viscometers. They work on common principles, though they differ in detail. The liquid under test is poured to a specified level into a container surround by water or oil bath providing temperature control at the base of the container is a small orifice with a simple valve control on opening valve, the time in seconds is recorded for a stated quantity of liquid to discharge into a measuring liquid below.

The different type of viscosity testing operator is there they are Efflux viscometer, Standard tar viscometer (10mm dia orifice and 50ml fluid to discharge), Saybolt furol viscometer (3mm dia orifice and 60ml fluid to discharge).

The bitumen is placed in to a standard tar viscometer or efflux viscometer and its temperature is raised to test temperature specified (35, 40, 45, 55& 60°C). When the temperature reaches respective test temperature orifice valve is open time elapse is noted to collect the bitumen of 50ml. The time required to collect a bottom container of 50ml is five indirectly the viscosity of bitumen. Then is specified in VG 10, VG20, VG 30 and VG 40.

4. **Specific gravity test:**

In most applications bitumen is weighed, but finally in use with aggregate the bitumen content is converted on volume basis. Hence determine of specific gravity value is required for conversion of weight to volume. Specific gravity of a binder doesn’t influence its behavior but all the same, its value is needed for mix design.

Specific gravity of bitumen varies from 0.97 to 1.02.

Specific gravity of tar varies from 1.16 to 1.28.

There are two methods to test the specific gravity of bitumen

a. Pycnometer method
b. Balance method
Generally balance method is used in that a cup of 50ml capacity is used and it is oiled before using. The bitumen is poured into cup and cooled and its weight e is noted and weight of cup with bitumen when immersed in distilled water is weighed f. Specific gravity of bitumen is the ratio of e to the difference between (e and f).

It is used to convert the weight in to volume. Determines Purity of bitumen if the impurity present in the bitumen by showing high value of specific gravity.

5. **Heat stability test:**
When a bituminous binder is heated continuously it starts emitting volatile vapors above a certain temperature and these volatile vapors can momentarily catch fire in form of flash and continued heating get fired.

a. **Flash point:**
The flash point of bitumen is that temperature at which it gives off vapors, which ignites in the pressure of a flame, but don’t continue to burn. The flame point is an induction of critical temperature at & above which suitable precautions should be taken to eliminate fire hazards. The ISI test describes the Penske-Martin method. The method involves a cup into which the bitumen is filled. The bitumen sample is then heated at a rate of 5-6°C/min stirring the material continuously.
The test flame is applied at intervals. The flash point is taken at the temperature read on the thermometer when flame causes a bright flash in the interior of cup in a closed system & at the surface of material in open system. It is 220°C.

b. **Fire point test:**
If heating is continued beyond the flash point, the vapors ignite in the pressure of a flame & continue to burn indicating the fire point temperature. There is no standard method to determine the spontaneous ignition temperature, which can only broadly indicate.

c. **Loss on heating test:**
The effect of heat on a bituminous binder is the loss of volatile constituents. This loss causes the binder to harden. Thus one method of testing the desirable property of a binder is to find out the loss on heating. This is achieved by an accelerated heating test a 50gm sample is weight is taken and maintained at a temperature of 160°C for 5hours. Then it expressed as a percentage of loss in original weight is determined.
6. **Solubility test:**

   It has already been indicated that all bitumen are substantially soluble in CS₂. This is one of the points that define bitumen. Hence any impurity in bitumen in the form of inert minerals, carbon, salts etc. could be quantitatively analyzed by dissolving the samples of bitumen in any of the two solvents.

   A sample of 2g of bitumen is dissolved in 100ml of solvent and filtered in soluble material is washed, dried and weighed then it is expressed in percent of original sample. The Indian specifications require 99% solubility.

7. **Thin film oven test:**

   In this test, a sample of bitumen is subjected to hardening conditions as would be expected during hot mixing operations. A 50ml sample of bitumen is placed in a flat bottomed sample pan 140mm inside diameter & 10mm deep, the weighed sample & container are placed in a shelf which rotates at 5 to 6 rpm for 5 hrs in a ventilated oven maintained at 163°C. The loss in weight of the sample is expressed as % of the original weight. This method is then used for identify short term aging or hardening of bitumen.

**Tar**

   Tar is the viscous liquid obtained when natural organic materials such as wood and coal carbonized or destructively distilled in the absence of air. Based on the materials from which tar is derived, it is referred to as wood tar or coal tar. It is more widely used for road work because it is superior.

   There are five grades of roads tar: RT-1, RT-2, RT-3, RT-4 and RT-5, based on their viscosity and other properties.

   RT-1 has the lowest viscosity and is used for surface painting under exceptionally cold weather as this has very low viscosity.

   RT-2 is recommended for standard surface painting under normal Indian climatic conditions.

   RT-3 may be used for surface painting, renewal coats and premixing chips for top course and light carpets.

   RT-4 is generally used for premixing tar macadam in base course.
RT-5 is adopted for grouting purposes, which has highest viscosity among the road tars.

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
The properties and requirements for five grades of road tars based on the above test results are given by the ISI are given in below table.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Property</th>
<th>Road Tar Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>RT-1</td>
</tr>
<tr>
<td>1</td>
<td>Viscosity by standard tar viscometer (10 mm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) at temperature, °C</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>(b) viscosity range, seconds</td>
<td>33-55</td>
</tr>
<tr>
<td>2</td>
<td>Equiviscous temperature (EVT) range, °C</td>
<td>32-36</td>
</tr>
<tr>
<td>3</td>
<td>Softening point, °C</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Specific gravity range at 27°C</td>
<td>1.16-1.26</td>
</tr>
<tr>
<td>5</td>
<td>Softening point of residue, °C Max.</td>
<td>48</td>
</tr>
<tr>
<td>6</td>
<td>Water content, percent by weight, Max.</td>
<td>0.5</td>
</tr>
<tr>
<td>7</td>
<td>Phenols, percent by volume, Max.</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Naphthalene, percent by weight, Max.</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Matter insoluble in toluene, percent by weight, Max.</td>
<td>22</td>
</tr>
<tr>
<td>10</td>
<td>Distillation fractions, percent by weight (g per 100 g) distilling:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) upto 200°C, Max.</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>(b) from 200° to 270°C</td>
<td>5-12</td>
</tr>
<tr>
<td></td>
<td>(c) from 270° to 300°C</td>
<td>4-10</td>
</tr>
<tr>
<td></td>
<td>Total distillation (b+c), Max.</td>
<td>16</td>
</tr>
</tbody>
</table>
Preparation of Tar

There are three stages in the production of road tar:

1) Carbonization of coal to produce crude tar
2) Refining or distillation of crude tar
3) Blending of distillation residue with distillate oil fractions to give the desired road tar.

a) High-Temperature Carbonization of Coal

The carbonization or destructive distillation of coal consists essentially of heating a thin layer of coal enclosed in a chamber of refractory brick-work for several hours at temperature about 1000° C. Majority there are two major methods for carbonization, they are:

a) Carbonization in Coke-ovens
b) Carbonization in gas-works retorts

Carbonization in Coke-Ovens

A batch of about 16 tons of coal is loaded into a coke-oven.

Coke oven consists of large thin box lined with brick, 40 feet long, 14 feet high and 1 ½ feet wide.

The charge of coal is heated for 18 hours at a temperature of 1200° C.

Each ton of coal yields 8 gallons of crude tar.
b) Distillation of Crude Tar

The crude tar obtained by the condensation of the vapours emitted from coal in the course of carbonization is subjected to distillation process.

The distillation or refining of tar is carried out by tar distillers.

The process consists, first heating the crude tar to remove water and some light oils (Benzole), then heating further and condensing the heavier vapour in a fractionating column.

The operation is carried out in two stages:

In the first stage, the tar passes through the tubes in the cooler part of the furnace at a temperature of 140°C.

It is then passed to a dehydration chamber where the pressure is released and water and light oil is released.

The remaining tar is then passed to the second stage of the pipe-still at a temperature of 300°C.

From pipe-still, tar passes to a chamber at a lower pressure where vaporization takes place.

The vapours are condensed in a fractionating column which forms fractions of different boiling point ranges.

The residue which is not distilled is base-tar or pitch.

In order of increasing boiling points they may be classified as light oil, carbolic oil, naphthalene oil, wash oil, anthracene oil.
c) Blending of Tar-Distillation Fractions to Produce Road Tar

It is evident from the above that a tar of a suitable viscosity for use on the roads could be left as residue simply by stopping the distillation at the appropriate point.

Road tar 1 and 2, on the basis of viscosity, having viscosities of 10 to 40 and 40 to 125 seconds at Standard Tar Viscosity (STV) at 30°C.

Type-A having high softening point is used for surface dressings and base courses. Type-B is used for wearing courses and carpets.

---

**PREPARATION OF ROAD TAR**

Type A = Base tar + Naphthalene oil  
Type B = Base tar + Wash oil + Anthracene oil

**Chemical Constitution of Tar**

It is estimated that there are over 10,000 compounds in tar. Out of this 300 have been separated. The distillate oils consist largely of aromatic hydrocarbons, with one or more methyl groups attached to the nucleus, with smaller quantities of aromatic hydroxy compounds, paraffinic hydrocarbons and heterocyclic compounds with oxygen, nitrogen or sulphur in the ring.

Dickinson developed a method called ‘solvent fractionation’ which uses n-hexane, benzene and pyridine as solvents to give five fractions. He divided up in this way tars produced from vertical-retort, horizontal-retort and coke-oven crudes and by measurement of mean...
molecular weights. Typical structures for the solvent fractions haven been suggested by spectroscopic examination on the basis of molecular weight and C/H ratio.

The differences in chemical structure between tars from different carbonization processes are reflected in different in their properties. Tars produced by carbonization in coke-ovens or horizontal retorts have more purely aromatic hydrocarbons compared to vertical retorts. Thus, where as in coke-oven tar distillate oils over 90 percent may consist of aromatic hydrocarbon of benzene, naphthalene, anthracene and phenanthrene series, similar oils from vertical retort tars contain up to 25% of phenolic material and the same amount of paraffins, this is because temperature reached in coke-ovens and horizontal retorts will be higher than continuous vertical retorts and the vapours evolved during carbonization are in contact with hot coke for a longer period.

Vertical-retort tars are often referred as low-aromatic tars while coke-oven and horizontal-retort tars as high-aromatic tars. In general, the high-aromatic class is distinguished by wider molecular weight range, higher specific gravity, higher pitch content and low phenolic content.

1. What are the differences between bitumen and tar? How is asphalt produced?
2. What are the tests conducted on bitumen? Mention the importance of each.
3. Enumerate the properties of Bitumen and Tar
4. Write a note on Bitumen and Tar. Explain the chemical constituents of bituminous road binders.
5. Explain the physical requirements of aggregates and bitumen.
6. What are the tests conducted on bitumen? Mention the importance of each.
7. Briefly explain the preparation of bitumen with neat figure.
8. Describe penetration test to be carried out on bitumen with standard values recommended for construction.
9. Mention the various tests conducted on Bitumen. Explain any three tests with neat sketches.
10. Differentiate between Bitumen and Tar. How is asphalt produces?
11. What are the important requirements of test to be carried out on bitumen for road work? explain important aspects or IS standard of each.
12. Explain briefly the procedure adopted in the laboratory along with neat sketch and limitations to be considered as per IS/IRC standards for bitumen.
13. Explain in brief the preparation of bitumen with a flow chart.
14. Explain the desirable properties of bitumen.

15. Describe the softening point test and thin film oven test and their significance.