BITUMINOUS MATERIALS

Introduction

Bituminous binders used in pavement construction works include both bitumen and tar. Bitumen is a petroleum product obtained by the distillation of petroleum crude where-as road tar is obtained by the destructive distillation of coal or wood. Both bitumen and tar have similar appearance, black in colour though they have different characteristics. Both these materials can be used for pavement works.

(i) paving bitumen from Assam petroleum, denoted as A-type and designated as grades A35, A 90, etc.

(ii) paving bitumen from other sources denoted as S-type and designated as grades S 35, S 90, etc.

Types of Bituminous Materials

Bituminous material used in highway construction may be broadly divided as

(i) Bitumen and

(ii) Tar

Bitumen may be further divided as petroleum asphalt or bitumen and native asphalt. There are different forms in which native asphalts are available. Native asphalts are those which occur in a pure or nearly pure state in nature. Native asphalts which are associated with a large proportion of mineral matter called as rock asphate
**Bitumen**

Crude petroleum obtained from different places are quite different in their composition. The portion of bituminous material present in the petroleum’s may widely differ depending on the source. Almost all the crude petroleum’s contain considerable amounts of water along with crude oil. Hence the petroleum should be dehydrated first before carrying out the distillation. General types of distillation processes are fractional distillation and

**Tests on Bitumen**

Bitumen is available in a variety of types and grades. To judge the suitability of these binders various physical tests have been specified by agencies like ASTM, Asphalt Institute, British Standards Institution and the ISI. These tests include penetration test, ductility tests, softening point test and viscosity test. For classifying bitumen and studying the performance of bituminous pavements, the penetration and ductility tests are essential.

The various tests on bituminous materials are

(a) Penetration tests  (b) Ductility tests  (c) Viscosity tests  
(d) Float test  (e) Specific gravity test  (f) Softening point test  
(g) Flash and Fire point test  (h) Solubility test  (i) Spot test  
(j) Loss on heating test  (k) Water content test

**Cutback Bitumen**

Cutback bitumen is defined as the bitumen, the viscosity of which has been reduced by a colatible diluents. For use in surface dressings, some type of bitumen macadam and soil bitumen it is necessary to have a fluid binder which can be mixed relatively at low temperatures. Hence to increase fluidity of the bituminous binder at low temperatures the binder is blended with a volatile solvent. After the cutback mix in construction work, the volatile gets evaporated and the
cutback develops the properties. The viscosity of the cutback and rate of which it hardens on the road depend on the characteristics and quantity of both bitumen and volatile oil used as the diluent. Cutback bitumen’s are available in three types, namely,

(i) Rapid Curing (RC)

(ii) Medium Curing (MC) and

(iii) Slow Curing (SC)

This classification is based on the rate of curing or hardening after the application. The grade of cutback or its fluidity is designed by a figure which follows the initials; as an example RC-2 means that it is a rapid curing cutback of grade 2. The cutback with the lowest viscosity is designated by numeral 0, such as RC-0 and SC-0. Suffix numerals 0, 1, 2, 3, 4 and 5 designate progressively thicker or more viscous cutbacks as the numbers increase. This number indicates a definite viscosity irrespective of the type of cutback; in other words, RC-2, MC-2 all have the same initial viscosity at a specified temperature. The initial viscosity values (in seconds, standard tar viscometer) of various grades of cutbacks as per ISI

Thus lower grade cutbacks like RC-0, RC-1 etc. would contain high prop solvent when compared with higher grades like RC-4 or RC-5, RC-0 and MC-0 may contain approximately 45 percent solvent and 55 percent bitumen, whereas, RC-5 and MC-5 may contain approximately 15 percent solvent and 85 percent bitumen.

Rapid Curing Cutbacks are bitumens, fluxed or cutback with a petroleum Distillate such as nephta or gasoline which will rapidly evaporate after using in construction, leaving the bitumen binder. The grade of the R.C. cutback is governed by the proportion of the solvent used. The penetration value of residue from distillation up to 3600°C of RC cutback bitumen is 80 to 120.

Medium curing cutbacks are 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. Hence the designation

‘medium curing’ is given to this cutback type. MC products have good wetting properties and so satisfactory coating of fine grain aggregate and sandy soils is possible.

Slow curing cutbacks 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 harden or set way slowly as it is a semi volatile material.

Various tests carried out on cut-backs bitumen are:

(a) Viscosity tests at specified temperature using specified size of orifice.

(b) Distillation test to find distillation fractions, up to specified temperature and to find the residue from distillation up to 360°C

(c) Penetration test, ductility test and test for matter soluble in carbon disulphide on residue from distillation up to 360°C

(d) Flash point test on cutback using Pensky Martens closed type apparatus.

Bituminous Emulsion

A bitumen emulsion is liquid product in which a substantial amount of bitumen is
suspended in a finely divided condition in an aqueous medium and stabilized by means of one or more suitable materials. An emulsion is a two phase system consisting of two immiscible liquids; the one being dispersed as fine globules in the other. Usually, bitumen or refined tar is broken up into fine globules and kept in suspension in water. A small proportion of an emulsifier is used to facilitate the formation of dispersion and to keep the globules of dispersed binder in suspension.

Some of the general properties of road emulsions are judged by the following tests

(i) Residue on Sieving: It is desirable to see that not more than 0.25 percent by w of emulsion consists of particles greater than 0.15 mm diameter.

(ii) Stability to Mixing with Coarse Graded Aggregate: This test carried out to fit the emulsion breaks down and coats the aggregate with bitumen too early before mixing is complete.

(iii) Stability to Mixing with Cement: This test is carried out to assess the stability emulsions when the aggregate contains large proportions of fines.

(iv) Water Cement: To know the percentage water in the emulsion which depend the type of the emulsion.

(v) Sedimentation: Some sedimentation may occur when a drum of emulsion is standing before use, but on agitation, the emulsion re-disperses and can be used.

(vi) Viscosity: The viscosity of emulsified bitumen should be low enough to be sprayed through jets or to coat the aggregates in simple mixing.

Three types of bituminous emulsion are prepared, viz., (i) Rapid Setting (RS), Medium Setting (MS) and (iii) Slow Setting (SS) types. Rapid Setting type emulsion is suitable for surface dressing and penetration macadam type of construction. Medium Setting type is used for premixing with coarse aggregates and Slow Setting type emulsion is suitable for fine aggregate
mixes.

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 material from which tar is derived, it is referred to as wood tar or coal tar; the latter is more widely used for road work because it is superior. Three stages for the production of road tar are

(i) Carbonization of coal to produce crude tar

(ii) Refining or distillation of crude tar and

(iii) Blending of distillation residue with distillate oil fraction to give the desired road tar.

There are five grades of roads tars, viz., 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. For grouting purposes RT-5 may be adopted, which has the highest viscosity among the road tars.

The various tests that are carried out on road tars are listed below

(i) Specific gravity test

(ii) Viscosity test on standard tar viscometer

(iii) Equi-viscous temperature (EVT)

(iv) Softening point
(v) Softening point of residue

(vi) Float test

(vii) Water content

(viii) Distillation fraction on distillation upto 200°C, 200°C to 270°C and 270°C to 330°C.

(ix) Phenols, percent by volume

(x) Naphthalene, percent by weight

(xi) Matter insoluble in toluene, percent by weight

The requirements for the five grades of road tars based on the above test results are given by the ISI. Bitumen and tar have black to dark brown colour. But bitumen is a petroleum product whereas tar is produced by the destructive distillation of coal or wood.

**Comparison between tar & bitumen**

<table>
<thead>
<tr>
<th><strong>Bitumen</strong></th>
<th><strong>Tar</strong></th>
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<tbody>
<tr>
<td>It has black to dark brown color</td>
<td>It also has black to dark brown in color</td>
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<tr>
<td>It is natural petroleum product</td>
<td>Tar is produced by the destructive distillation of coal or wool</td>
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<tr>
<td>It is soluble in carbon disulphide &amp; in carbon tetrachloride</td>
<td>Tar is soluble only in toluene</td>
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<tr>
<td>Property</td>
<td>Bitumen</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Weather resisting property</td>
<td>better</td>
</tr>
<tr>
<td>Temperature susceptibility</td>
<td>less</td>
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<tr>
<td>Free carbon content</td>
<td>less</td>
</tr>
<tr>
<td>Aggregate binding and retention</td>
<td>neither</td>
</tr>
<tr>
<td>Presence of water</td>
<td>well</td>
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It binds aggregate more easily & retain it better in the presence of water.