## BITUMINOUS MATERIALS

Bituminous materials or asphalts are extensively used for roadway construction, primarily because of their excellent binding characteristics and water proofing properties and relatively low cost.

Production of Bitumen - Bitumen is the residue or by-product when the crude petroleum is refined. A wide variety of refinery processes, such as the straight distillation process, solvent extraction process etc. may be used to produce bitumen of different consistency and other desirable properties. Vacuum steam distillation of petroleum oils In the vacuum-steam distillation process the crude oil is heated and is introduced into a large cylindrical still.

Steam is introduced into the still to aid in the vaporization of the more volatile constituents of the petroleum and to minimize decomposition of the distillates and residues. The volatile constituents are collected, condensed, and the various fractions stored for further refining, if needed. The residues from this distillation are then fed into a vacuum distillation unit, where residue pressure and steam will further separate out heavier gas oils. The bottom fraction from this unit is the vacuum-steam refined asphalt cement.

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. There are different types of cutback bitumen like rapid curing (RC), medium curing (MC), and slow curing (SC). 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.

Three types 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. Bituminous primers In bituminous primer the distillate is absorbed by the road surface on which it is spread. The absorption therefore depends on the porosity of the surface. Bitumen primers are useful 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.

Requirements of Bitumen: In general, Bitumen should posses following desirable properties.

- The bitumen should not be highly temperature susceptible: during the hottest weather the mix should not become too soft or unstable, and during cold weather the mix should not become too brittle causing cracks.
- The viscosity of the bitumen at the time of mixing and compaction should be adequate. This can be achieved by use of cutbacks or emulsions of suitable grades or by heating the bitumen and aggregates prior to mixing.
- There should be adequate affinity and adhesion between the bitumen and aggregates used in the mix.

**TABLE 15 COMPARISON BETWEEN BITUMEN AND TAR**

| Sl.No. | Bitumen | Tar |
|---|---|---|
| 1 | Hydrocarbon material found in gaseous, liquid, semi-solid or solid form obtained during the distillation of petroleum | Viscous liquid produced when natural organic materials such as coal, petroleum, wood, etc are carbonized. |
| 2 | Blackish Brown colour | Blackish Brown colour |
| 3 | Faster Stripping action | Slower Stripping action |
| 4 | Less Temperature Susceptibility | More Temperature Susceptibility |
| 5 | More durability | Less durability |
| 6 | Good Water Resistance | Poor Water Resistance |
| 7 | Soluble in carbon-di-sulphide | Soluble in Toulene |

**TABLE 16 COMPARISONS BETWEEN DIFFERENT TYPES OF BITUMEN**

| Straight Run Bitumen | Cutback bitumen | Bitumen Emulsion |
|---|---|---|
| It is the one distilled to a definite viscosity or penetration without further treatment | Bitumen mixed with a volatile solvent. | It is the liquid product formed by mixing together molten bitumen with hot water in the presence of an emulsifying agent |
| | Types:<br>Rapid curing (RC) Cutback bitumen<br>Medium curing (MC) Cutback bitumen<br>Slow curing (SC) Cutback bitumen | Types:<br>Rapid Setting (RS)<br>Medium Setting (MS)<br>Slow Setting (SS) |

## TESTS ON BITUMEN PENETRATION TEST ON BITUMEN

The penetration test is carried out to find the softness of bitumen by penetration test.

Apparatus - Container, Needle, Water Bath, Penetrometer, Stop Watch.

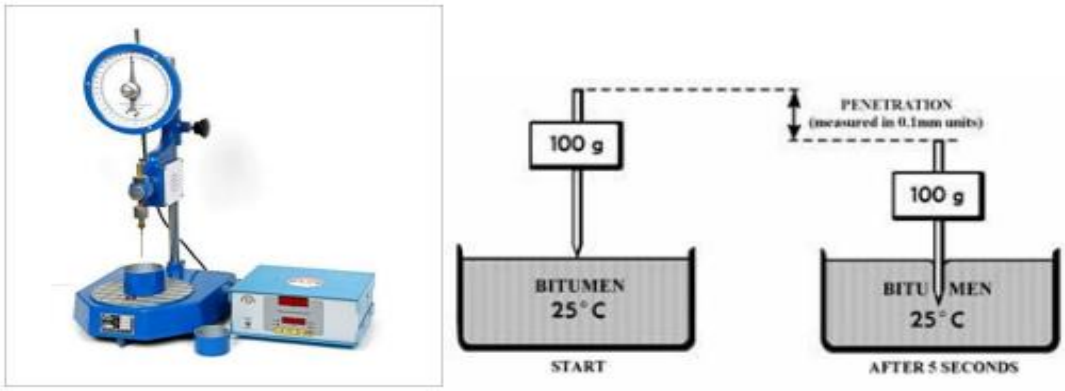


**FIG.19 PENETROMETER APPARATUS**

**Procedure:**

- The Bitumen is softened to a pouring consistency between 75o and 100o C above the approximate temperature at which bitumen softens.
- The sample material is then poured into a container to a depth at least 15mm more than the expected penetration.
- The sample containers are cooled in atmosphere of temperature not lower than 13 oC for one hour.
- Then they are placed in temperature-controlled water bath at a temperature of 25oC for a time of one hour.

- The needle is cleaned with benzene, dried and loaded with the weight.
- The total moving load required is 100 + 0.25 gms, including the weight of the needle, carried and super-imposed weights.
- Using the adjusting screw, the needle assembly is lowered and adjusted in such a way that the tip of the needle is in contact with the surface of the sample.
- The pointer of the dial is made to read zero or the initial dial reading is noted.The needle is released for exactly five seconds. Final readings are taken on the dial gauge.
- Three penetration tests are made at least on the sample by testing at distances of 10mm apart. After each trial, the needle is disengaged and wiped with benzene and dried. Mean of three trials is reported as penetration value.

**TABLE 17 PENETROMETER READING ON BITUMEN**

| Penetrometer dial reading | Test 1 | Test 2 | Test 3 |
|---|---|---|---|
| Initial | | | |
| Final | | | |
| Penetration value | | | |
| Mean Penetration Value | | | |

**Penetration test** is a commonly adopted test on bitumen to grade the material in terms of its hardness. A 80/100 grade represents the penetration value ranges between 80 and 100 at standard test conditions. The grading of bitumen helps to assess its suitability for use in different climatic conditions and types of construction. The Penetration values of various types of bitumen used in pavement construction in this country range between 20 and 225 for bituminous macadam and penetration macadam, IRC suggests bitumen grades 30/40, 60/70 and 80/100.

In warmer regions lower penetration grades are preferred to avoid softening whereas higher penetration grades like 180/200 are used in colder regions so that

excessive brittleness does not occur. Highest penetration grade is used in spray application works. This test is used for bitumen only and cannot be used for tar as they are very soft materials.

**DUCTILITY TEST ON BITUMEN:** Ductility is the distance in centimetres that a standard briquette of bitumen will stretch before breaking. Apparatus

1. Briquette mould
2. Ductility machine
3. Water bath
4. Knife

**Procedure:**

- The bitumen sample is melted to a temperature of 75 to 100oC above the approximate softening point until it is fluid.
- It is strained thro' IS sieve 30, poured in the mould assembly and placed on brass plate, after a solution of glycerin and dextrin is applied at all surfaces of the mould exposed to bitumen.
- 30 to 40 minutes after the sample is poured into the moulds, the plate assembly is placed in water bath at 27oC for 30 minutes.
- The sample and the mould assembly is removed from water bath and excess bitumen material is cut off by leveling the surface using hot knife.
- After trimming the specimen, the mould assembly containing the sample is replaced in water bath maintained at 27oC for 85 to 95 minutes.
- The sides of the mould are removed and the clips are carefully hooked on the machine without any initial strain. The pointer is set to read zero.
- Two or more specimens are prepared in the moulds and clipped to the machine so as to conduct these tests are in operation, it is checked whether the sample is immersed in water at depth of atleast 10 mm.
- The distance at which the bitumen thread of each specimen breaks is recorded (in cm) to report as ductility value.

FIG. 20 DUCTILITY APPARATUS ON BITUMEN

**Ductility:** For various grades of bitumen varies from 5 to 100. For satisfactory use in road pavement, ductility value should not be less than 50 cm. Ductility value is affected by factors like pouring temperature, briquette dimensions, presence of air voids in briquette, rate of pull and test temperature.

**SOFTENING POINT TEST ON BITUMEN:** The softening point is the temperature at which the substance attains a particular degree of softening under specified condition of test. Generally higher softening indicates lower susceptibility and is preferred in warm climates.

Apparatus:

- The ring and ball apparatus (Steel balls, Brass rings, Ball guides, Support)
- Thermometer
- Bath
- Electric Heater

**Procedure**

- In the ring and ball apparatus, a brass ring containing test sample is suspended in a liquid like water or glycerin at a given temperature.
- A steel ball is placed upon the bitumen sample and liquid medium is then heated at the rate of five degree centigrade per minute. The temperature at which the softened bitumen touches the metal placed at a specified distance below the ring is recorded as the softening point of bitumen.
- Preparation of test sample: Heat the material to a temperature between 75–100 oC

above its softening point; stir until, it is completely fluid and free from air bubbles and water. If necessary filter it through IS sieve 30. Place the rings, previously heated to a temperature approximately to that of the molten material, on metal plate which has been coated, with a mixture of equal parts of glycerin and dextrin. After cooling for 30 minutes in air, level the material in the ring by removing the excess with a warmed, sharp knife.

- Assemble the apparatus with the rings, thermometer and ball guides in position.
- Fill the bath with distilled water to a height of 50 mm above the upper surface of the rings. The starting temperature should be 5 oC.
- Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5 + 0.5oC per minute.
- As the temperature increases the bituminous material softens and the ball sinks through the ring, carrying a portion of the material with it.
- Note down the temperature when any of the steel ball with bituminous coating touches the bottom plate.
- Record the temperature when the second ball also touches the bottom plate. The average of the two readings to the nearest 0.5 oC is reported as the softening point.

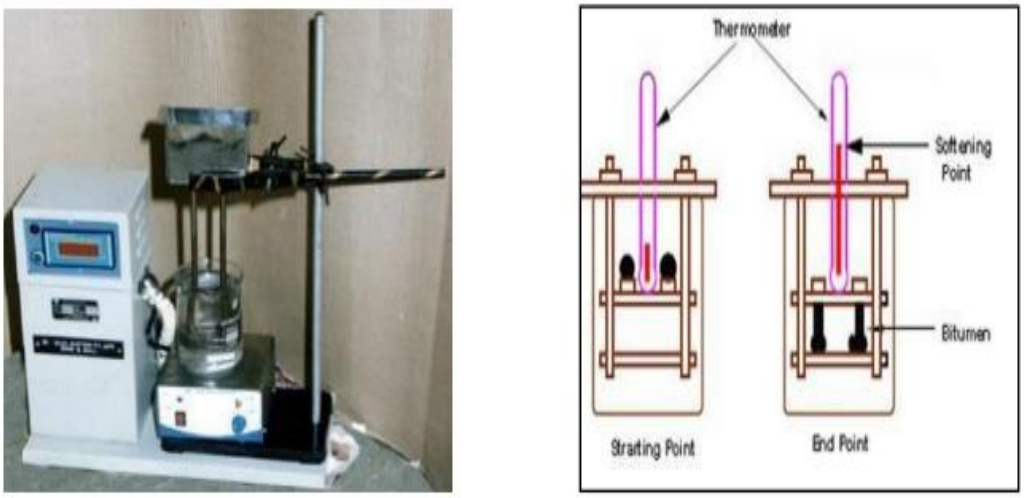


FIG. 22 SOFTENING POINT TEST APPARATUS ON BITUMEN

Softening point indicates the temperature at which binders possess the same viscosity. Bituminous materials do not have a definite melting point. Rather the change of state from solid to liquid is gradual and over a wide range of temperature. Softening point has particular significance for materials that are to

be used as joint and crack fillers. Higher so softening point ensures that they will not flow during service. In general, the higher the softening point the lesser the temperature susceptibility. Bitumen with higher softening point may be preferred in warmer places. Softening point of the bitumen to be used as paving bitumen should lie between 35 o C to 70 o C.