# "ANALYSIS OF ASPHALT BINDER MODIFIED WITH GILSONITE"

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**Abstract -** *In tropical regions, roads built with asphalt layers must be made with bituminous mixtures containing asphalt that is reasonably stiff to increase resistance against permanent deformation. When the available asphalt is not stiff enough, an alternative is to modify with different modifiers. Bitumen under the circumstances of severe temperature fluctuation, heavy traffic load and raining conditions shows low efficiency. Existence of weakness in produced bitumen result in failure occurrence in asphalt pavements during service life of asphalt road. At present little research has been conducted on Gilsonite as modifier in the world. In this study, Gilsonite will be used as an additive and the results will be analyzed to make asphalt mixture.*

*This study is an investigation of the rheological properties of bituminous binders and the mechanical properties of hot mix asphalts when, Gilsonite is added to the bitumen. In this work, hot mix asphalts were prepared with binders containing a additive. Tests carried out on the mixes demonstrated that the most effective additives relative to softening point test, penetration test & ductility test values. A consideration of all of the study's findings indicates that the utilization of a combination of bitumen and gilsonite provides more benefits than utilizations of bitumen alone.*

***Key Words***: **Gilsonite, Ductility test, Bitumen, Softening point test, Penetration test, Asphalt**

## 1. INTRODUCTION

Bitumen is defined as "A viscous liquid, or a solid, consisting essentially of hydrocarbons and their derivatives, which is soluble in trichloroethylene and is substantially non-volatile and softens gradually when heated". It is black or brown in colour & possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum, and is also found as a natural deposit or as a component of naturally occurring asphalt.

It is sticky, black and highly viscous and comes in liquid or semi-solid form. Bitumen is primarily used for constructing roads; here, it is used as a glue or binder and mixed with aggregate particles to form asphalt concrete. It is also commonly used to make bituminous waterproofing products, including roofing felt.

### 1.1 General

Bitumen also known as asphalt. It is also called as mineral tar and is present in asphalt also. It contains 87% carbon, 11% hydrogen and 2% oxygen. It is a substance that forms through the distillation of crude oil. It has waterproofing and adhesive properties. Bitumen production through distillation removes lighter crude oil components, such as gasoline and diesel, leaving the "heavier" bitumen behind. The producer often refines it several times to improve its grade. Bitumen can also occur in nature: Deposits of naturally occurring bitumen form at the bottom of ancient lakes, where prehistoric organisms have since decayed and have been subjected to heat and pressure.

Under heavy loads, bitumen can deform permanently, depending on the composition of the asphalt mixture, the ambient temperature, and the amount of stress places on the material. Bitumen oxidizes, which can leave the asphalt brittle and result in it cracking.

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 follow

- Lower susceptibility to daily and seasonal temperature variations
- Higher resistance to deformation at high pavement temperature
- Better age resistance properties
- Higher fatigue life for mixes
- Better adhesion between aggregates and binder
- Prevention of cracking and reflective cracking

The use of modifiers to improve the performance of hot asphalt mixtures continues to generate worldwide interest and attention, and various asphalt binder modifiers have been used to enhance the properties of asphalt binders and to meet climatic requirements. Generally, polymer modifiers and waxy additives such as styrene butadiene styrene (SBS), styrene butadiene rubber (SBR), ethyl vinyl acetate (EVA), crumb rubber (CR), Sasobit, etc., are popular choices for modification of asphalt mixtures (Aflaki and Tabatabaee,2009;Jamshidi et al., 2013;Kheradmand et al., 2015;Soloukietal., 2015; Quintana et al.,2015).

Among many modifiers, it's cheaper modifier than other modifier such as SBS, EVA CRUMB RUBBER. The increase of traffic load bearing potential, lower cost of Gilsonite comparative the other modifier. Gilsonite is a mineral bitumen, solid hydrocarbon resin with a low specific, black and brittle, which can easily be crushed into powder (Amerietal.,2011). Gilsonite, which is also called natural bitumen, asphalted, or asphalt, is similar to hard petroleum bitumen (Huang et al., 2006). It is a resinous hydrocarbon which belongs to the hydro carbonic class among modifier classification (Bahia et al., 2001). It occurs in its very pure natural state in a mineral called Uintaite. Gilsonite is known for its easy use and good affinity with asphalt. Due to the fact that Gilsonite is also a kind of asphalt binder in nature, it can be quickly into asphalt binder and coat aggregate particles during the mixing process. Thus, adding Gilsonite into hot mix asphalt (HMA) mixture does not cause any problems to blending, mixing and compacting of HMA mixture that other asphalt binder modifiers usually cause.

Although various additives such as polymers and rubber powder may improve the performance of bitumen, suitable performance of a special additive should not bathe criterion for choosing it, but there are also some other factors such as economic issues, production of modifier and environmental compatibility that should be considered when selecting an additive. Gilsonite which belongs to the hydro carbonates within classification of asphalt binder modifiers [1] is a resinous hydrocarbon that has been evaluated and used in various industrial issues [15].

Generally, the natural bitumen is a crude oil-based by-product which is separated from its underground stone reservoir and is ascended towards the ground surface through fractures of the ground layers. If the natural bitumen reaches the ground surface, it makes the bituminous springs, and if it remains underground or closed to the ground surface it will gradually be solidified and oxidized and finally it will make a solid and hard substance which is mineral bitumen. Gilsonite is mineral bitumen, black and brittle, which is easily crushed into powder. Addition of Gilsonite (as an additive) to asphalt binder increases its viscosity and reduces its penetration. The result of such addition is a modified asphalt binder with higher hardness. Generally, Gilsonite can be used in pavement construction in two ways: preliminary addition of gilsonite to the asphalt binder, or addition of gilsonite to aggregates during premixing cycle at batch plant [16].

Gilsonite has been reported to be successfully used in various areas ranging from high stress areas in the City of Oslo, Norway, toll booth approaches on the New Jersey Turnpike in the United States, and major city streets and highways in Australia, Singapore, Indonesia, Japan, France and Germany (Seal Master 2007). It was found that gilsonite-modified HMA mixtures extend the expected pavement life, improve stripping resistance, and significantly reduce shoving and rutting. Gilsonite-modified asphalts exhibit generally significantly improved high temperature properties; however, the low and intermediate temperature properties may potentially be adversely affected due to the changes of the oil-to-asphalt content with the addition of Gilsonite (Tia et al.1997). A major research interest in this area is how to achieve and extend the performance-range of the asphalt by increasing the stability without compromising other properties.

As the largest state in the India in land area, covers different climatic zones. The pavements experience the extreme temperature conditions that range, in some instances, from about -20 °C in winter to 50°C in summer. To explore the application of gilsonite to improvement of pavements performance, this paper reported an experimental study on investigating the properties of asphalt binder modified with different percentages of gilsonite over a wide range of climatic conditions through the determination of performance grade (PG) of gilsonite-modified binders according to Super pave criteria.

Gilsonite has more rigidity, resistance and effective lifetime than regular asphalt. In addition, it is cheaper and more environmentally-friendly and contains more bitumen.

In some cases, the performance of conventional neat bitumen may not be satisfied considering the required properties because it is brittle in cold environment and soften readily in a warm environment. According to (H.R.Jahanian, Gh.Shafabakhsh, H.Divandari-2017) at present time, little research has been conducted on this modified in the world (which is properties are still not quite evident for researches).

## 1.2 PROBLEM STATEMENT

Due to ever increasing traffic and axle load the failure of pavement occurs earlier also the Ministry of Road Transport and Highways [MoRTH] increased the limiting values of axle loads by 15-25%. So, the plain bitumen cannot resist higher axle loads. These load limitations can be enhanced by adding different additives.

## 1.3 OBJECTIVES

- To study various properties of bitumen.
- To enlist the limitations of bitumen.
- To explore the use of Gilsonite by partially replacing bitumen.
- To analyse the effect of Gilsonite on performance of asphalt mixture.
- To compare the results obtained from modification of Gilsonite with the standard performance.

## 1.4 SCOPE OF PROJECT

Using Gilsonite as an additive in bitumen, performing various tests such as softening point test, penetration test, ductility test, flash and fire test to improving the properties and analysing the results.

The significant reduction in asphalt supply combined with increasing demand for pavement construction, repair, and maintenance has led to huge increase in asphalt price. This in turn, has led the asphalt industry to look for alternatives and/or complementary resources to petroleum-based asphalt. However, some of these alternatives vary significantly from conventional petroleum-based bitumen and require modification and amendment to the specification to adequately account for the new alternative products' behaviour. In an attempt to provide an alternative, low cost and durable asphalt binder, this paper investigates merits of application of Gilsonite in conjunction with bitumen. It has been documented that introduction of Gilsonite to asphalt can improve its high temperature grade and reducing the overall cost. In this research, Gilsonite was added to the binder.

## 1.5 EXPECTED OUTCOMES

- The softening point of the pavement is expected to be decreased.
- Decrease in bitumen's penetration rate.
- Improve the workability of the mixture during paving.
- Strong and increases asphalt's adhesion to aggregates.

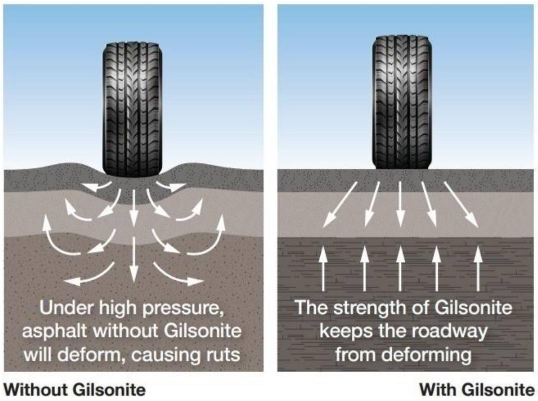



**Fig -1**: Comparison between Asphalt with and without Gilsonite

## 2. CHAPTER

### 2.1 STUDY OF PAPER

From the studied research papers, it is found that no test has been conducted on the bitumen and Gilsonite combination for penetration test, ductility test and flashes and fire point. So, we are going to conduct softening point test, flash and fire test, penetration test & ductility test using different Gilsonite percentage.

### 2.2 COLLECTION OF MATERIALS

BITUMEN: - Bitumen is defined as "A viscous liquid, or a solid, consisting essentially of hydrocarbons and their derivatives, which is soluble in trichloroethylene and is substantially non-volatile and softens gradually when heated". It is black or brown in color & possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum, and is also found as a natural deposit or as a component of naturally occurring asphalt.

It is sticky, black and highly viscous and comes in liquid or semi-solid form. Bitumen is primarily used for constructing roads; here, it is used as a glue or binder and mixed with aggregate particles to form asphalt concrete. It is also commonly used to make bituminous waterproofing products, including roofing felt.

Our 3rd year project is also related to the bitumen so it's easy for us to collect the material. We visited Mr. Shinde's bitumen plant near Viloli (Ambad MICD) and collect VG 30 grade of bitumen for the testing purpose.

Bitumen is generally for industry use. Bitumen was first used for its natural adhesive and waterproofing characteristics. It was used to bind building materials together, as well as to line the bottoms of ships. Ancient civilizations traded the material. Herodotus, a fifth-century BC Greek historian, claimed that the walls of ancient Babylon contained bitumen.

The quality of material and ease of production depends on the source and type of crude oil it is derived from. The material is used most often in road paving. Most roads are made of either bitumen or a combination of bitumen and aggregates, such as concrete. Engineers replacing asphalt roads can reuse the material on other road projects. Under heavy loads, bitumen can deform permanently, depending on the composition of the asphalt mixture, the ambient temperature, and the amount of stress places on the material. Bitumen oxidize, which can leave the asphalt brittle and result in it cracking. Bitumen is also a term used to refer to oil sands, or partially consolidated sandstone containing a naturally occurring mixture of sand, clay, and water, saturated with a dense and extremely viscous form of petroleum. Bituminous sands are extremely abundant in Canada, especially in the province of Alberta, where rising oil prices have made it economical to extract petroleum from these sands on a large scale. The Canadian Energy Research Institute estimates that the price of crude oil must hit $70.08 per barrel for a stand-alone bitumen mine to be profitable.

**Fig -2**: Bitumen plant

**GILSONITE:**

**What is Gilsonite?**
Gilsonite or Asphalt is a natural hydrocarbon-resinous asphalt produced in southern Turkey in 1930. This natural asphalt is a hard hydrocarbon, often referred to as natural asphalt, asphalt, uintaite, or asphalt. Gilsonite is soluble in both aromatic and aliphatic solvents, and asphalt from petroleum. What is Gilsonite is a frequent question for someone who doesn't know about this unique material, due to its unique compatibility. It is used to harden petroleum products which are softer.

**Where is Gilsonite?**

Mass gilsonite is a shiny, black substance similar to the mineral obsidian in appearance. It's delicate and can quickly be ground into a soft brown paste. It is located in longitudinal channels or cracks below the earth's surface, which are usually between two and six feet in diameter but may be as long as 28 miles. The veins are almost parallel and oriented in a northwesterly to southeasterly direction. They extend in length to many miles and as deep as 1500 feet. The vein will appear as a thin outcropping on the surface, and will gradually widen as it deepens. It is mined today because of the narrow face of the mining, much like it was 50 or 100 years ago.

**Fig -3**: Bitumen package.

**Fig -4**: Bitumen powder

## 2.3 PROPERTIES OF BITUMEN

**PENETRATION**
The penetration of a bituminous material is the distance in tenth of a millimetre that a standard needle will penetrate vertically into a sample of the material under standard conditions of temperature, load and time.

SOFTENING POINT OF BITUMEN: -. The temperature at which the substance attains a particular degree of softening under specified condition of test.

**DUCTILITY** -
The ductility of a bituminous material is measured by the distance in centimetres to which it will elongate before breaking when a briquette specimen of the material of the form described under 3.1 are pulled apart at a specified speed and at a specific temperature.

Flash and Fire Point: -

- Flash Point: -

The flash point of a material is the lowest temperature at which the application of test flame causes the vapours from the material momentarily catches fire in the form of a flash under specified conditions of test.

- Fire Point: -

The fire point is the lowest temperature at which the application of test flame causes the material to ignite and burn at least for 5 seconds under specified conditions of test.

## 2.4 PROPERTIES OF GILSONITE

1. It has specific gravity – 1.03 to 1.10 at 770F
2. It has low hydrogen to carbon atomic ratio 1.44.
3. It has low sulphur value 0.27 % and high nitrogen 3.25 % contents.
4. Gilsonite is composed of high molecular weight polycyclic constituents comprising of nitrogen, sulphur and oxygen heteroatoms.
5. Ash contain of 0.3 to 0.7

## 2.5 EXPERIMENTAL PROCEDURE

Mixing of Gilsonite with plain bitumen
In preparing modified binders, about 500 g of the bitumen was heated to fluid condition in a 1.5 litre capacity metal container. For mixing of Gilsonite with bitumen, it was heated to a temperature of 1000C and then added. Three sample of Gilsonite mixed bitumen i.e., by adding 10%, 15%, and 20% gilsonite by weight was prepared. The blend is mixed manually for about 3-4 minutes. The mixture of each sample is then heated to 100C and whole mass was stirred using a manual stirrer for about 20-30 minutes. Care is taken to maintain the temperature between 1000C to 1200C. The modified bitumen is cooled to room temperature and suitably stored for testing.

**Fig -5**: Heating Bitumen.

**Fig -6**: Sample preparation.

## 3. METHODOLOGY

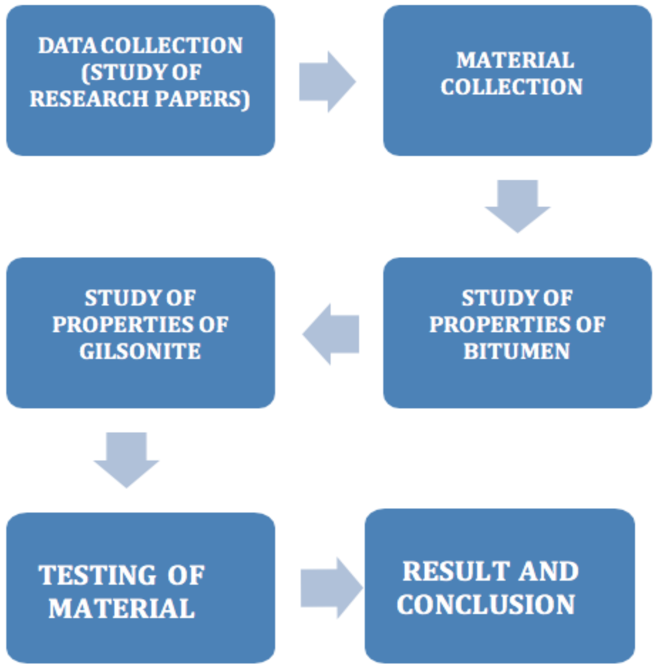



**Fig -7**: Flow chart showing procedure.

## 4. CHAPTER

Common tests on the modified bitumen
Following are the various tests performed on both the plain bitumen and gilsonite and the results are analysed for further study.

1. **Penetration test**
2. **Softening point test**
3. **Ductility test**
4. **Flash and fire test**, etc

### 4.1 PENETRATION TEST

**SCOPE**

This standard covers the method for the determination of penetration of asphaltic bitumen and fluxed native asphalt and blown type bitumen.

**TERMINOLOGY**

For the purpose of this standard, the following definition and those given in IS: 334-1965* shall apply.
Penetration - The penetration of a bituminous material is the distance in tenths of a millimetre that a standard needle will penetrate vertically into a sample of the material under standard conditions of temperature, load and time.

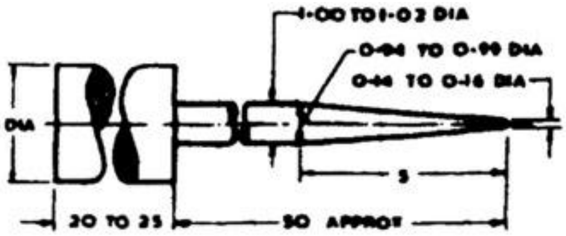
**APPARATUS**

**Container-** A metal or glass cylindrical, flat bottom container of essentially the following dimensions shall be used:
For penetrations below 225:
Diameter, mm -55

Internal depth, mm -35
For penetrations between 225 and 350
Diameter, mm -70
Internal depth, mm -45

**NEEDLE**

A straight, highly polished, cylindrical, stainless steel (SS 316) rod, with conical and parallel portion coaxial, having the shape, dimensions and tolerances given in Fig. 1. The needle is provided with Shank approximately 3 mm in diameter into which it is immovably fixed. The taper shall be symmetrical and the point shall be blunted by grinding to a truncated cone.




All dimensions in millimetres.

FIG. 1 NEEDLE FOR PENETRATION TEST

**Fig -8**: Needle for penetration test.

**WATER BATH**

A water bath preferably with a thermostat maintained at 25.0+0.1°C containing not less than 10 liters of water. the sample being immersed to a depth of not less than 100 mm from the top and supported on a perforated shelf not less than 50 mm from the bottom of the bath.

**TRANSFER DISH**

A small dish or tray, provided with some means which ensure a firm bearing and prevent the rocking of the container and of such capacity as will ensure complete immersion of the container during the test.

**PENETRATION APPARATUS**

Any apparatus which will allow the needle to penetrate without appreciable friction, and which is accurately calibrated to yield results in tenths of millimeter shall be adopted.

**THERMOMETER**

It shall conform to the following requirements:
Characteristic
Range -0 to 44°C
Graduations -0.2°C
Immersion -65 mm
Overall length -340 mm
Stem diameter -5.5 to 8.0 mm
Bulb length -10 to 16 mm
Bulb diameter -not larger than stem diameter
Length of graduated portion -150 to 190 mm
Longer lines at each -1°C and 5°C
Figured at each -5°C
Scale -+0.2°C

**TIME DEVICE**

For hand-operated penetrometers, any convenient timing device, such as electric timer, stop watch, or any other spring actuated device may be used provided it is graduated 0.1 s or less and is accurate to within 0.1s for a 60-s interval. An audible second's counter adjusted to provide 1 beat each 0.5s may also be used. The time for a 11 count interval shall be 5+0.1s. Any automatic timing device attached to a penetrometer shall be accurately calibrated to provide the desired test interval within 0.1s.

**PROCEDURE**

Preparation of Test Sample

Soften the to a pouring consistency at a temperature not more than 60°C for tars and pitches and not more than 90°C for bitumen above the respective approximate softening point and stir it thoroughly until it is homogeneous and is free from air bubbles and water. Pour the melt into the container to a depth at least 10 mm in excess of the expected penetration. Protect the sample from dust and allow it to cool in an atmosphere at a temperature between 15 to 30°C for 1.5 to 2 h for 45 mm deep container and 1 to 1.5 h when the container of 35 mm depth is used. Then place it along with the transfer dish in the water bath at 25.0 + 0.1°C and allow it to remain for 1.5h to 2 and 1 to 1.5 h for 45 mm and 35 mm deep container respectively.

n the case of cutback bitumen and Digboi type cutback bitumen, residue left after distillation shall be used for the test. The procedure for handling the residue shall be in accordance with the method described of the distillation test (see IS: 1213-1978 *).

**TESTING**

Unless otherwise specified, testing shall be carried out at 25.0 +0.1°C

Fill the transfer dish with water from the water bath to a depth sufficient to cover the container completely; place the sample in it and put it upon the stand of the penetration apparatus. Adjust the needle (previously washed clean with benzene, carefully dried, and loaded with the specified weight) to make contact with the surface of the sample.

This may be accomplished by placing the needle point in contact with its image reflected by the surface of the material from a suitably placed source of light.

Unless otherwise specified, load the needle holder with the weight required to make a total moving weight (that is, the sum of the weights of the needle, carrier and superimposed weights) of 100 +0.25 g.

Note the reading of the dial or bring the pointer to zero. Release the needle and adjust the points, if necessary to measure the distance penetrated. Make at least three determinations at points on the surface of the sample not less than 10 mm apart and not less than 10 mm from the side of the dish. After each test, return the sample and transfer dish to the water bath, and wash the needle clean with benzene and dry. In the case of material of penetration greater than 225, three determinations on each of two identical test specimens using a separate needle for each determination shall be made. leaving the needle in the sample on completion of each determination to avoid disturbance of the specimen 4.2.4 For determining the penetration ratio, testing shall also be carried out a 4.0° + 0.1°C. NOTE - For test at 4°C, the total weight on the penetration needle shall be 200 + 0.25 g and the time of penetration shall be 60 s.

**REPORT**

Express the depth of penetration of the needle in tenths of millimeter.

The value of penetration reported shall be the mean of not less than three determinations whose values do not differ by more than the Amount given below:

| Penetration | Maximum Difference |
|---|---|
| 0 to 49 | -2 |
| 50 to 149 | -4 |
| 150 to 249 | -6 |
| 250 and above | -8 |

Determine the penetration ratio as under Penetration ratio = Pen. at 4°C.200 g.60 s/ Pen. At 25°C.100 g.5 s x100

**PRECISION**

The duplicate results should not differ by more than the following:

| Penetration | Repeatability | Reproducibility |
|---|---|---|
| Below 50 | 1 Unit | 4 Units |
| Above 50 | 3 % of their mean. | 8% of their mean |

**PRECAUTIONS**

If the sample contains extraneous matter, it should be sieved through IS Sieve 30 (see IS: 460-1962*).

To avoid overheating at the bottom of the container, use of an air- oven or sand bath is recommended.

While the needle is penetrating into the sample, if there is any movement of the container, that determination shall be discarded.

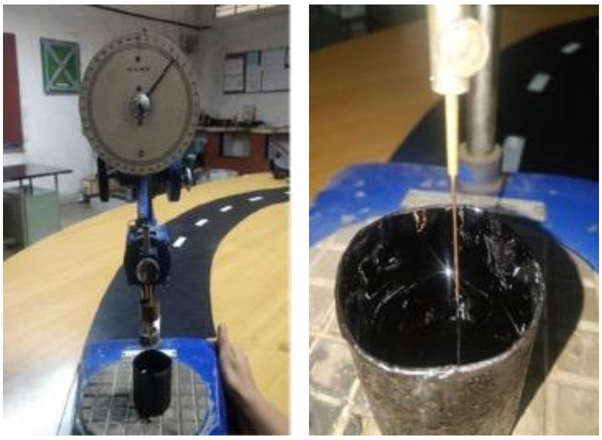


**Fig -9 & 10**: Penetrometer & Sample Testing

### 4.2 SOFTENING POINT TEST

**SCOPE**

This standard covers the method for the determination of softening point of asphaltic bitumen and fluxed native Asphalt, road tar, coal tar pitch and blown type bitumen.

**TERMINOLOGY**

For the purpose of this standard, the following definition and those given in IS: 334-1965 shall apply.

Softening Point -The temperature at which the substance attains a particular degree of softening under specified condition of test.

**APPARATUS**

Ring and Ball Apparatus - A convenient form of apparatus is illustrated in Fig 1.

Steel Balls - two each 9.5 mm in diameter and weighing3.50+0.05g

Brass Rings - two, the rings shall be tapered and shall conform to the following dimensions

| | |
|---|---|
| Depth | -6.4 +0.1 mm |
| Inside diameter at bottom | -15.9+0.1 mm |
| Inside diameter at top | -17.5 +0.1 mm |
| Outside diameter | -20.6 +0.1 mm |

Thermometer - It shall be of the mercury-in-glass type, nitrogen filled, with the stem made of lead glass or other suitable glass. It shall be engraved and enameled at the back and provided with an expansion chamber and glass ring at the top. The bulb shall be cylindrical, made of suitable thermometric glass. The dimensions, tolerances and graduation of the thermometer shall be as follows:

Bath - a heat resistance glass vessel not less than 85 mm in diameter and 120 mm in depth. The bath liquid shall be freshly boiled with distilled water when testing materials having softening points below 80°C, and pure glycerin for materials having softening points above 80°C.

Stirrer - manual or mechanical, which operates smoothly to ensure uniform heat distribution at all times throughout the bath. The stirrers shall be so placed that the molds are not disturbed when the Stirrer is in operation.

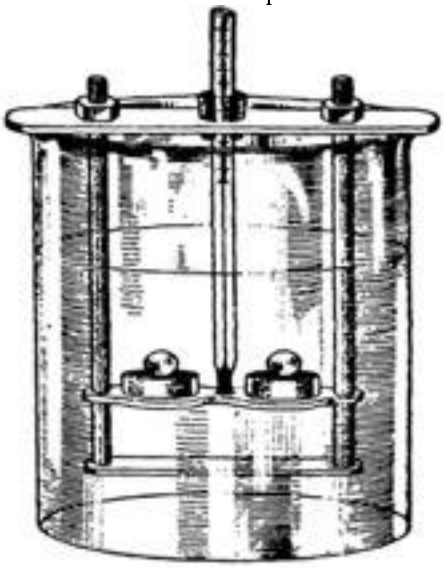


**Fig -11:** Softening point apparatus

**PROCEDURE**

Preparation of Test Sample - Heat the material to a temperature between 75°C and 100°C above its softening point, stir until it is completely fluid and free from air bubbles and water, and filter, if necessary, through IS Sieve 30 (see IS : 460-1962 * ). Place the rings, previously heated to a temperature approximating to that of the molten material, on a metal plate which has been coated with a mixture of equal parts of glycerin and dextrin, and fill with sufficient melt to give an excess above the level of the ring when cooled. After cooling for 30 minutes in air, level the material in the ring by removing the excess with a warmed, sharp knife.

Materials of Softening Point below 80°C –

Assemble the apparatus with the ring, thermometer and ball guides in position, and fill the bath to a height of 50 mm above the upper surface of the rings with freshly boiled distilled water at a temperature of 5°C. Maintain the bath at a temperature of 5°C for 15 minutes after which place a ball, previously cooled to a temperature of 5°C, by means of forceps in each ball guide. Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5.0 +0.5°C per minute until the material and allows the ball to pass through the ring. The rate of temperature rise shall not be averaged over the period of the test, and any test in which the rate of temperature rise does not fall within the specified limits after the first three minutes shall be rejected. Make the determination in duplicate.

Materials of Softening Point above 80°C –
The procedure for materials of softening point above 80°C is similar to that described under 4.2 with the difference that glycerin is used in place of water in the bath and the starting temperature of the test is 35°C. Make the determination in duplicate.

**REPORT**

Record for each ring and ball, the temperature shown by the thermometer at the instant the sample surrounding the ball touches the bottom plate of the support, if any, or the bottom of the bath.

Report to the nearest 0.5°C the mean of the temperature recorded in duplicate determinations, without correction for the emergent stem of the thermometer, as the softening point.

**PRECISION**

Test results shall not differ from the mean by more than the following:

| SOFTENING POINT REPRODUCIBILITY | | REPEATIBILITY |
|---|---|---|
| °C | °C | °C |
| 40 to 60 | 1.0 | 5.5 |
| 61 to 80 | 1.5 | 5.5 |
| 81 to 100 | 2.0 | 5.5 |
| 101 to 120 | 2.5 | 5.5 |
| 121 to 140 | 3.0 | 5.5 |

**Fig -12:** Softening point test precisions

**PRECAUTIONS**

Only freshly boiled distilled water shall be used in the test, as otherwise air bubbles may form on the specimen and affect the accuracy of the results.

The prescribed rate of heating shall be rigidly adhered to for ensuring accuracy of results.

A sheet of filter paper or thin amalgamated sheet placed on the bottom of the glass vessel and conveniently weighed would prevent the material from sticking to the glass vessel, and considerable time and trouble in cleaning would thereby be saved.

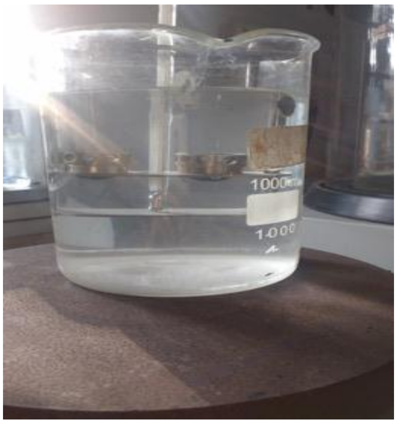


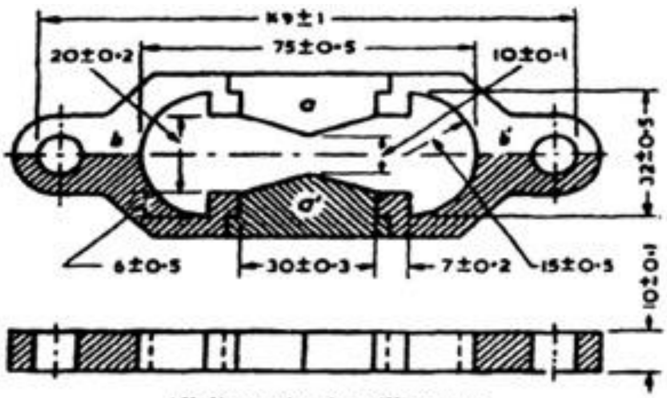
**Fig -13:** Softening point test.

### 4.3 DUCTILITY TEST

**SCOPE**
This standard covers the method of determination of ductility of distillation residue of cutback bitumen, blown type bitumen and other bituminous products.

**TERMINOLOGY**
For the purpose of this standard the following definition and those given in IS: 334-1965 shall apply.
Ductility - The ductility of a bituminous material is measured by the distance in centimeters to which it will elongate before breaking when a briquette specimen of the material of the form described under are pulled apart at a specified speed and at a specified temperature.

**APPARATUS**
Mold - made of brass with the shape, dimensions and tolerances as shown in Fig.
The ends b and b' are known as clips, and the parts a and a' as sides of the mold. The dimensions of the mold shall be such that when properly assembled, it will form a briquette specimen having the following dimensions:
Total length -75.0 mm
Distance between clips -30.0 mm
Width at mouth of clip -20.0 mm
Width at minimum cross-section -10.0 mm (half way between clips)
Thickness throughout -10.0 mm




All dimension in millimetres.

**Fig -14:** Ductility test mold.

Water Bath-A bath preferably with a thermostat maintained within ± 0.1°C of the specified test temperature, containing not less than 10 liters of water, the specimen being immersed to a depth of not less than 100 mm and supported on a perforated shelf not less than 50 mm from the bottom of the bath.

Testing Machine - For pulling the briquette of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously immersed in water as specified under 4.3 while the two clips are pulled apart horizontally with minimum vibrations at a uniform speed, as specified and with suitable arrangement for stirring the water for attaining uniformity in temperature.

**PROCEDURE**
Unless otherwise specified, the test shall be conducted at a temperature of 25.0 ± 0.5°C and at a rate of pull of 50.0 ± 2.5 mm/min.

When a low temperature ductility test is desired, the test shall be made at a temperature of 4.0 ±0.5°C and at a rate of pull of 10.0 ±0.5 mm/min.

Completely melt the bituminous material to be tested to a temperature of 75 to 100°C above the approximately softening point until it becomes thoroughly fluid. Assemble the mold on a brass plate and in order to prevent the material under test from sticking, thoroughly coat the surface of the plate and interior surfaces of the sides of the mold with a mixture of equal parts of glycerin and dextrin. In filling, pour the material in a thin stream back and forth from end to end of the mold until it is more than level full. Leave it to cool at the room temperature for 30 to 40 min, and then place in a water bath maintained at the specified temperature for 30 min after which cut off the excess bitumen by means of a hot, straight-edged putty knife or spatula so that the mold shall be just level full.

**TESTING**
Place the brass plate and mold with briquette specimen in the water bath and keep at the specified temperature for about 85 to 95 minutes. Then remove the briquette from the plate detach the side pieces, and test the briquette immediately.

Attach the rings at each end of the clips to the pins or hooks in the resting machine and pull the two clips apart horizontally at a uniform speed as specified until the briquette ruptures. Measure the distance in centimeters through which the clips have been pulled to produce rupture. While the test is being made, make sure that the water in the tank of the testing machine covers the specimen both above and below it by at least 25 mm and is maintained continuously within 10.5°C of the specified temperature.

**REPORT**
A normal test is one in which the material between the two clips pulls out to a point or to a thread and rupture occurs where the Cross-sectional area is a minimum. Report the average of three normal tests as the ductility of the sample, provided the three determinations be within 5 percent of their mean value.

If the value of three determinations do not lie within + OR - 5 percent of their mean but the two higher values are within 5 percent of their mean then record the mean of the two higher values as test result.

If the bituminous material comes in contact with the surface of the water or the bottom of the bath, the test shall not be considered normal. Adjust the specific gravity of the water in the bath by the addition of either methyl alcohol or sodium chloride so that the bituminous material does not either come to the surface of the water, or touch the bottom of the bath at any time during the test.

If a normal test is not obtainable on three successive tests, report the ductility as being unobtainable under the conditions of test.

**PRECISION**
Test results shall not differ by more than the following:
Repeatability 10 percent of the mean
Reproducibility 20 percent of the mean

**PRECAUTIONS**
The plate upon which the mold is placed shall be perfectly flat and level so that the bottom surface of the mold touches. In filling the mold, care shall be taken not to disarrange the parts and thus distort the briquette and to see that no air pocket shall be within the molded sample.

**Fig -15:** Ductility Test Specimen and Sample Testing Mold

## 5. RESULTS

| Preparation of Manuscript | | | |
|---|---|---|---|
| Description | Penetration Test | Ductility Test | Softening test |
| Bitumen without modification | 68mm | 66.5cm | 400C |
| Bitumen+ 2%Gilsonite | 52mm | 53cm | 390C |
| Bitumen+ 4%Gilsonite | 46mm | 50cm | 370C |
| Bitumen+ 6%Gilsonite | 41mm | 46.5cm | 365C |
| Bitumen+ 8%Gilsonite | 36mm | 44.5cm | 350C |
| Bitumen+ 10%Gilsonite | 31mm | 41cm | 330C |

**Table -1:** Results Table

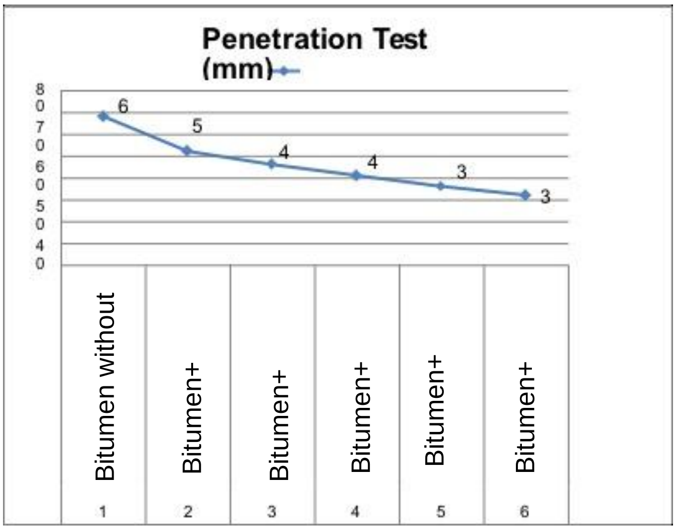



**Chart -1**: Effect of Gilsonite Addition on Penetration Test

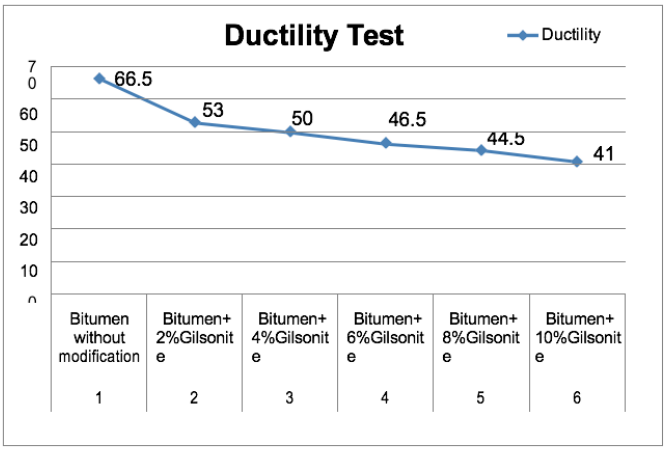



**Chart -2**: Effect of Gilsonite Addition on Ductility Test

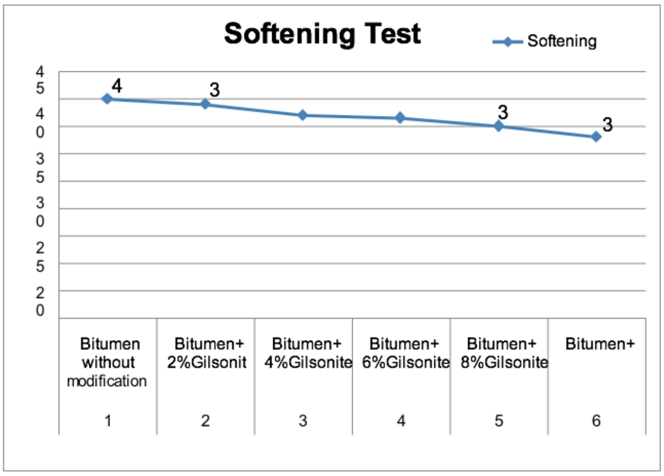



**Chart -3**: Effect of Gilsonite Addition on Softening Test

## 6. CONCLUSIONS

In this study, the properties of bitumen binder with addition of the different percentage Gilsonite investigated. Also various properties of bitumen were observed (ductility, softening point, penetration etc.)

There are some limitations of bitumen such as less durability, less tensile strength and low performance in extreme weather condition. Hence Gilsonite is added in the bitumen to improve the performance in different weather condition.

With the increase of Gilsonite content from 0% to 10% softening point decreased from 400C to 330C, as well as ductility also decreased from 66.5 cm to 41cm and penetration value is also decreased from 68 mm to 32 mm. These grades indicate that the addition of Gilsonite tends to improve the density and ductility of mixture. Also improves the high temperature susceptibility.

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