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# Sustainable Use of Waste Plastic Materials to Strengthen the Adhesion Properties of Viscous Grade Asphalt Mixtures

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## Abstract -

It is not new to use polythene in road construction. Some aggregates are highly hydrophilic (water loving). Like bitumen, polythene is also hydrophobic (water hating) in nature. So the addition of hydrophobic polythene by dry or wet mixing process to bituminous mix lead to improvement of strength, water repellent property of the mix. Polythene gets added to hot bitumen mixture and the mixture is laid on the road surface like a normal tar road. In the Plastic roads we use plastic carry-bags, disposable cups, polythene packets that are collected from garbage as important ingredients of the construction material. To improve the fatigue life, reduce the rutting & thermal cracking in the pavement it is necessary to go through polymer modification processes. There are series of tests carried out in the laboratory to ascertain the suitability of bitumen as main material in pavement design. The raw materials used in this investigation were locally available and these include bitumen of VG-10, VG-20, VG-30,VG40 grades, aggregates of size 10 mm, and plastic waste like plastic bottles, plastic bags. The Percentage of Plastic waste added to bitumen is 5 %, 10%, 15%, 20%. Various Tests performed to know the performance of plastic waste bitumen compared to normal bitumen

***Key Words***: hydrophilic, hydrophobic, bitumen

## 1.INTRODUCTION

Asphalt, also known as bitumen is a sticky, black, and highly viscous liquid or semi- solid form of petroleum. It may be found in natural deposits or may be a refined product, and is classed as a pitch. The primary use (70%) of asphalt is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete. Its other main uses are for bituminous waterproofing products, including production of roofing felt and for sealing flat roofs.

Worldwide, geologists tend to favor the term "bitumen" for the naturally occurring material. For the manufactured material, which is a refined residue from the distillation process of selected crude oils, "bitumen" is the prevalent term in much of the world; various forms of asphalt are sometimes referred to as "tar", as in the name of the La Brea Tar Pits, although tar is a different material.

## 2. Body of Paper

In the 1970s, US introduced the method of viscosity grading at 60 degree Celsius.
This was to ensure a solution for construction problems and to have high temperature performance. These were tender mixes that must undergo mix pushing and shoving under the roller, without which it cannot be rolled properly.
Prior to 1970s, the US construction used 60 to 70 penetration grade that shows variation towards rutting action. They showed lower viscosity at 135 degree Celsius.
This caused tender mix problems during the construction process. The viscosity test, unlike penetration grading, is a fundamental test carried out at 60 degree Celsius. This temperature is the maximum temperature to which the road pavement is subjected to at summer. The measurement is in terms of Poise.
In India, the equipment for testing the viscosity at 60 and 135 degrees are available. They are very simple to handle with.

**VG-10 BITUMEN:** VG-10 is widely used in spraying applications such as surface dressing and paving in very cold climate in lieu of old 80/100 Penetration grade. It is also used to manufacture Bitumen Emulsion and Modified Bitumen products.

**VG-20 BITUMEN**: VG-20 is used for paving in cold climate & high altitude
regions.

**VG-30 BITUMEN**: It is a kind of bitumen, which is produced during the process of oxidation of vacuum bottom in distillation tower and is categorized based on its viscosity grade. The main common usage of bitumen VG-30 is primarily used to construct extra heavy duty Bitumen pavements that need to endure substantial traffic loads. Also, VG30 is in road construction, waterproofing, building construction industries and also in cutback bitumen production. It can be used in lieu of 60/70 Penetration grade. It is the most suitable for use in hot and rainy weather condition and suitable to be used in mild regions.

**VG-40 BITUMEN**: VG-40 is used in highly stressed areas such as intersections, near toll booths and truck parking lots in lieu of old 30/40 Penetration grade as shown in fig:1.6. Due to its higher viscosity, stiffer
Bitumen mixes can be produced to improve resistance to shoving and other problems associated with higher temperature and heavy traffic loads.

The objective of this study is to reduce plastic waste by using it in constructions and also to determine the strength properties of the plastic added bitumen that is
used in the pavement construction i.e., in construction of roads. The most available and mostly used bitumen grade is VG 40 and the bitumen grade used in this study is VG40.If this study gives the best results that are to be expected
then this will be a milestone achievement in construction, as plastic has become a major threat to the environment. Therefore the main objectives of this study can be summerised by the following:

- To reduce plastic waste and provide eco-friendly nature
- To use that waste plastic in construction of roads which will have greater lifespan .

Plastics can be classified in many ways, but most commonly by their physical properties. Plastics may be classified also according to their chemical sources. The twenty or more known basic types fall into four general groups: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins,

Elastomers and Fibers. But depending on their physical properties, may be classified as thermoplastic and thermosetting materials.

In course of this study, there are series of tests carried out in the laboratory to ascertain the suitability of bitumen as main material in pavement design. Tests carried out on all the materials such as bitumen, aggregates, waste plastic.

**TESTS ON BITUMEN**

- Penetration test
- Ductility test
- Softening point test
- Specific gravity test
- Viscosity test
- Flash and Fire point test
- Float test
- Water content test
- Loss on heating test.

**Tests and Results:**

- Penetration test of the bitumen determines the hardness or softness of the bitumen and it is also used to measure the consistency of the bitumen.

| Grades of Bitumen | As per IS: 1203 |
|---|---|
| VG 10 | 80 |
| VG 20 | 60 |
| VG 30 | 45 |
| VG 40 | 35 |

Table 1: grades of bitumen and its Penetration Test values

| % of Plastic waste added to Bitumen | Test results |
|---|---|
| 5 | 37 |
| 10 | 42 |
| 15 | 55 |
| 20 | 63 |

Table 2: plastic added bitumen and its results.

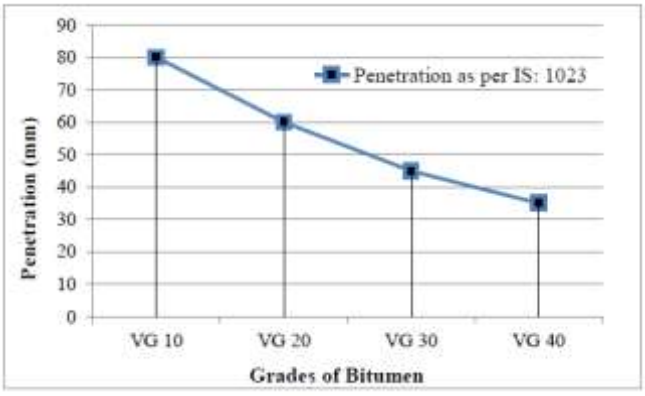


Fig 1: penetration Vs bitumen grades

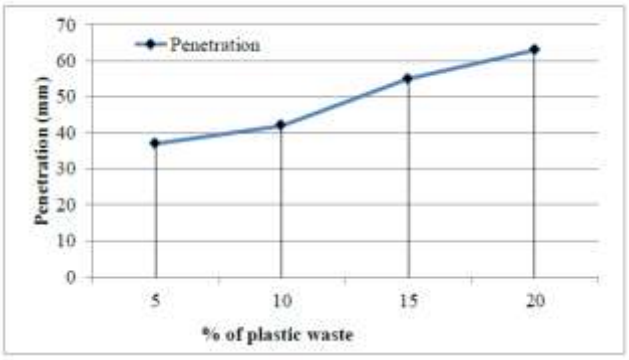


Fig 2: penetration Vs % of waste plastic.

Ring and ball test is used to determine the softening point of bitumen, asphalt and coal tar. This test consists of two brass ring and two steel ball, using which the softening point of various bituminous materials are determined.

| Grades of Bitumen | As per IS: 1205 |
|---|---|
| VG 10 | 40 |
| VG 20 | 45 |
| VG 30 | 47 |
| VG 40 | 50 |

Table 3: grades of bitumen and its Softening Point values

| % of Plastic waste added to Bitumen | Test results |
|---|---|
| 5 | 54 |
| 10 | 54 |
| 15 | 56 |
| 20 | 57 |

Table 4: plastic added bitumen and its results.

The ductility of a material is the ability of that material to undergo plastic deformation (permanent deformation) before the rupturing (breaking) of that material. The values for different grades of bitumen as per IS are given in the below table 5

| Grades of Bitumen | As per IS: 1208 |
|---|---|
| VG 10 | 75 |
| VG 20 | 50 |
| VG 30 | 40 |
| VG 40 | 25 |

Table 5: ductility values for different grads of bitumen

| % of Plastic waste added to Bitumen | Test results |
|---|---|
| 5 | 92 |
| 10 | 85 |
| 15 | 69 |
| 20 | 58 |

Table 6: plastic added bitumen and its results.

Flash and Fire point test is conducted on bitumen to know the safe mixing and application temperature values of particular

bitumen grade. the values for flash and fire point for different bitumen grades as per Indian standards are given in table7.

| Grades of Bitumen | As per IS: 1448 | |
|---|---|---|
| | Flash | Fire |
| VG 10 | 175 | 180 |
| VG 20 | 175 | 180 |
| VG 30 | 175 | 180 |
| VG 40 | 175 | 180 |

Table 7: flash & fire point values for different bitumen grades

| % of Plastic waste added | Test results | |
|---|---|---|
| | Flash | Fire |
| 5 | 173 | 180 |
| 10 | 178 | 184 |
| 15 | 185 | 191 |
| 20 | 190 | 198 |

Table 8: flash and fire point values for modified bitumen.

This test attempts to get the optimum binder content for the aggregate mix type and traffic intensity. This is the test which helps us to draw Marshall Stability vs. %bitumen.

| % of Plastic coated | Stability (KN) | Flow (mm) | Bulk density (g/cm$^3$) | Air voids (%) |
|---|---|---|---|---|
| 5 | 8.77 | 3.21 | 2.333 | 4.15 |
| 10 | 9.72 | 3.45 | 2.285 | 3.92 |
| 15 | 9.84 | 3.57 | 2.329 | 3.87 |
| 20 | 9.55 | 3.84 | 2.324 | 3.93 |

Table 9: marshall stability values for different % of plastic added bitumen.

The graphical representation of marshall stability values for different percentages of plastic added to bitumen are shown in the graph below:

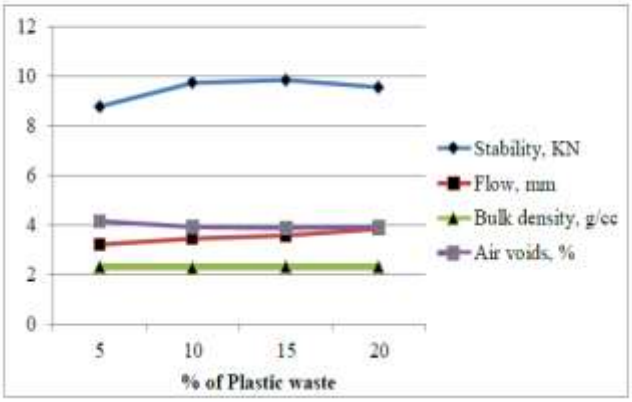


Fig:3 marshall values Vs % of plastic added.

## 3. CONCLUSIONS

It was concluded that the plastic waste added to the bitumen gave the better results than that of the normal bitumen when tested. The addition of 20% plastic waste to the bitumen, when tested gave the better results and hence the marshall stability test values are also suitable.

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