

# Upgrading of Rheological Properties of Bitumen with Waste Plastic

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**Abstract** Usually plastics are disposed in land filling and are burnt in free atmosphere which are detrimental to health. Land filling may affect water recharge, diminishing soil microbial activity, water line and drainage clogging. If waste plastic reaches to its ignition temperature, it evolves nontoxic gases which can cause abnormality in human beings. Thus its disposal is really a hard problem due to its non-biodegradability and unaesthetic view. Eventually Engineers have come across the point to use waste plastic as a binder material in its melt condition. This method has helped us a safe disposal of plastics junk, with operative rheological properties in the construction of pavement. Plastic bottles, packing containers and shopping bags production is increasing gradually, these results in the increase of waste plastic. Low Density Polyethylene (LDPE) with different percentage by weight of bitumen was mixed with 60/70 grade bitumen. Standard Tests on bitumen were conducted for this purpose i.e. Penetration Test, Flash Point and fire point Test, Softening Point and Binder Density. Low Density Polyethylene (LDPE) was mixed with bitumen that showed better result for the tests.

**Keywords** Low Density Polyethylene, Rheological Properties, Non-biodegradability

## 1. Introduction

Waste plastic production deposition is a problem. Plastic is a non-biodegradable material it creates environmental contamination. Usually bitumen, aggregates, sand and stone are used for road construction. Natural materials are decreasing slowly and price of natural material is growing daily. Engineers are trying to have alternative materials for the construction of highways. And at last waste production is one in the category. Dumping and combustion problems might be reduced up to a limit, if these materials are utilized properly in construction of highways. it will benefits us in the following ways:

- (a) It will strengthen our national economy.
- (b) It will help to clear the earth surface from deposits of

wastes.

- (c) It will save the natural materials being exhausted.
- (d) It will also help in saving the environment.

The daily increase in high intensity of traffic and seasonal temperature variation require the rheological properties and characteristics of highway to be improved. The rheological properties are improved by using plastic waste as a binder material in melt condition, which has helped us to reach the result for safe dumping of waste plastic.

Using pure bitumen in wearing and base course can cause different failures like showing, bleeding in hot weather and longitudinal, transverse cracks and potholes in cold weather. In such conditions we cannot apply heavy axle load on pavement structure. In the present conditions it is necessary to reorient bitumen by adding modifier to upgrade the rheological properties.

## 2. Literature Review

The notion of plastic was as a strength enhancer and its utilization in the flexible pavement has been studied in India since 2000. In flexible pavements construction bitumen keep bond between the aggregates with each other. Bitumen increases the strength and life time but it is weak to counter water penetrating into it. Its qualities are improved by modifying properties of bitumen by merging it with plastics. The rheological properties of plastic mix are compared with ordinary Bitumen, and penetration test showed a result in decreasing order while softening point, flash and fire point test and binder density of plastic mix bitumen showed a result in increasing order. The relation of increase and decrease is valid up to 12% by weight. Thus pavement life is increased by using modified bitumen in surfacing coarse.

Prof.C.E.G. Justo [4] had said by the mixing of 8% waste plastic by mass to the bitumen may save 0.4% of bitumen by mass which results in increasing the rheological properties of bitumen. S. Rajasekaran and Dr. R.Vasudevan[5] had said that modified bitumen exhibits good binder properties compared with ordinary bitumen.

Modified bitumen has decreased Penetration value and increased softening point.

### 3. Methodology

0.5 kg of 50 micron plastic bags (LDPE) was brought for conducting the project work to observe the rheological properties of plastic mix with bitumen. Required thicknesses of the Plastic bags were sorted in Laboratory. Plastic bags were cleaved into pieces so that it can pass through 4.75mm sieve. Bituminous material was heated to its melting temperature from 160°C to 170°C. Calculated percentage of plastic by mass of bitumen was dissolved slowly into bitumen for about 30 minutes up to the melting temperature. It was mixed with hot bitumen for 30 minutes to show homogenous mixture. The melting temperature of bitumen was kept constant. Different calculated percentage of Bitumen and plastic sample were made for conducting Empirical tests.

### 4. Rheological Properties

#### Softening Point of Bitumen

AASHTO T 53-96

This test revealed the softening point of bitumen from 30 to 157 °C. Softening point apparatus is immersing in distilled water (30 to 80°C). This test is useful in the classification of bitumen and is pointing out the material to flow at specific temperature.

#### Penetration of Bituminous Materials

AASHTO T 49-96

The test showed the penetration of solid and semi-solid bituminous materials. The graph below point out that waste plastic is efficient to increase the empirical properties of bitumen.

#### Flash and Fire Point

AASHTO T 48-96

The test revealed the flash and fire points of bituminous materials. This is clear that with the addition of waste plastic to bitumen their actual property increases. Graph below shows relationship between bitumen and waste plastic.

#### Binder Density

AASHTO T 228 and ASTM D 70-97

Binder density of bituminous materials changes with temperature; Binder density tests are handy in making volume adjustments dependent upon temperature. The outcome of this test is to figure out the density of bituminous materials.

### 5. Conclusions

This paper concludes a successful way to reuse plastic waste as a modifier with bitumen for the construction of flexible pavement. The use of plastic waste with bitumen from 8-10% by mass will help in enhancing the rheological properties. The decrease in penetration value and increase in flash and fire point, softening point indicate that bitumen is reoriented. Modified bitumen has reduced the failures like potholes, bleeding, cracks, and rutting causes due to the change of seasonal temperature variation. Disposal of waste plastic in such way is environment affectionate.

**Table 1.** Rheological Tests Conducted on Ordinary and Modified Bitumen

S.NO	LDPE %age	Bitumen %age	Softening Point(°C)	Penetration Value(0.1mm)	Flesh Point(°C)	Fire Point(°C)	Binder Density
1	0	3	54	65	235	251	1.015
2	3	3	65	55	239	265	1.019
3	6	3	73	50	245	280	1.025
4	9	3	85	39	252	295	1.029
5	10	3	88	0	260	299	1.033
6	11	3	90	0	261	304	1.035
7	12	3	93	0	263	308	1.039
8	15	3	104	0	270	325	1.047

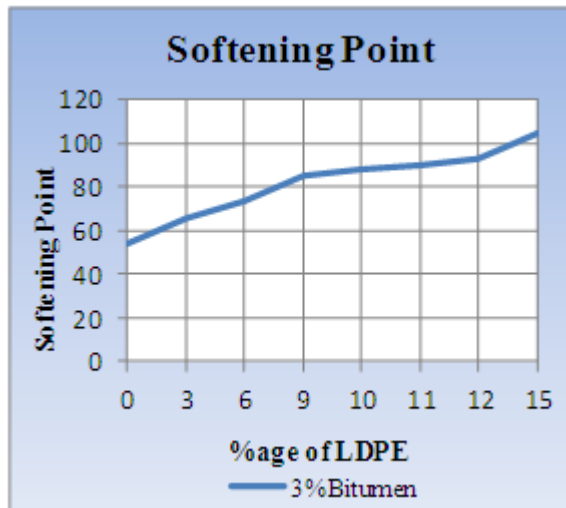


Figure 1. Softening Point Test Result

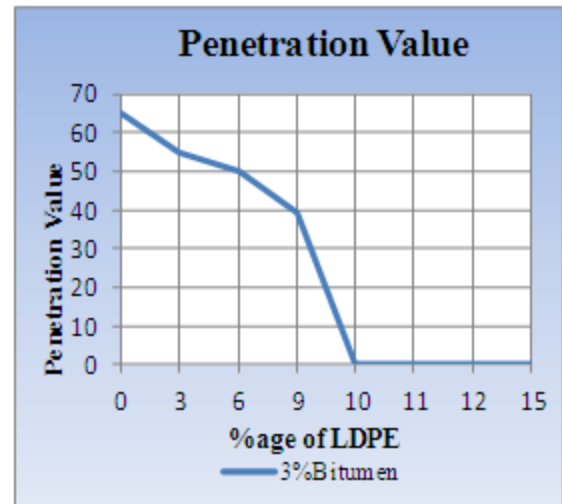


Figure 4. Penetration Test Result

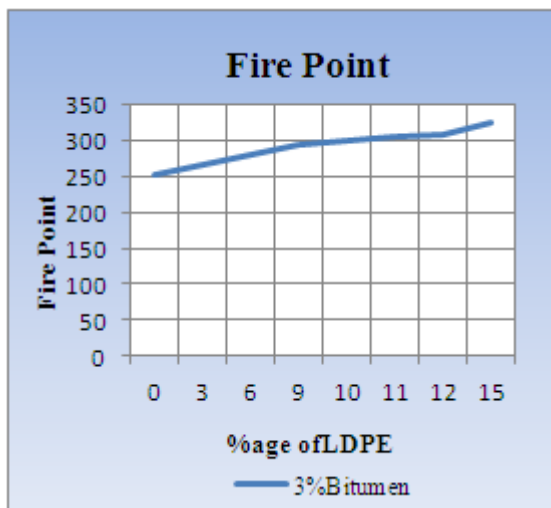


Figure 2. Fire Point Test Result

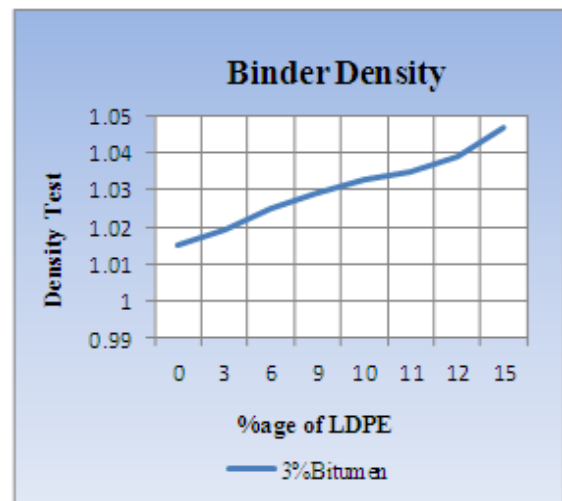


Figure 5. Binder Density Test Result

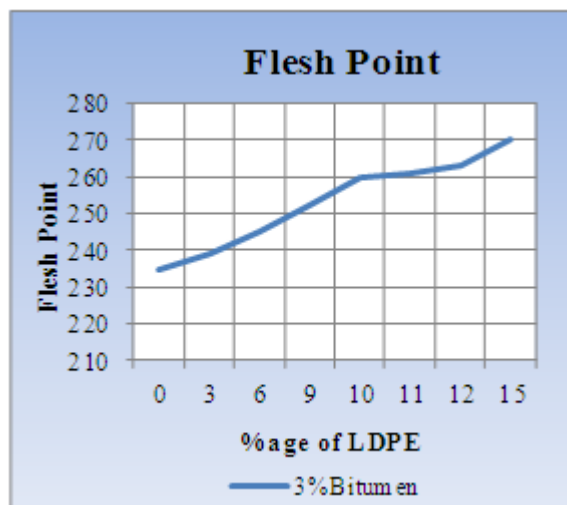


Figure 3. Flesh Test Result

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