USE OF WASTE PLASTIC BLENDED BITUMEN FOR ROAD CONSTRUCTION

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Abstract*: Generating disposable plastic is becoming a major problem in many countries. As these are non-biodegradable there is a major problem posed to the society with regard to the management of these solid wastes. Using waste plastic as a secondary material in construction projects would be a solution to overcome the crisis of producing large amount of waste plastics in one hand and improving the structure's characteristics such as resistance against cracking on the other hand. This study aimed to investigate the effects of adding plastic in road pavement. In this research work waste plastic (Low Density Polyethylene) is used as modifier to prepare samples required for tests to determine the properties of the modified bitumen. Other objectives of the research were to analyze the effect of waste plastic modified bitumen on road quality. The study results conclude that rheological properties like penetration, ductility of bitumen is improved after addition of LDP. It is expected that using the output of this research, the waste plastic materials can be used in bituminous roads works, resulting in minimization of the frequency of rehabilitation work and thereby providing an economic solution. It is also expected to substantially reduce volume of environmentally hazardous plastic and environmental pollution.*

Keywords: waste plastic; low density polyethylene, penetration, ductility.

1. INTRODUCTION

Increasing urbanization and industrialization have contributed for increased plastic generation. Safe disposal of waste plastic is a serious environmental problem. They pose a threat to the environment essentially due to the lack of an efficient collection and disposal system, as they are non-biodegradable. Plastics are most commonly used in the form of carry bags, packaging material, containers etc. Due to accumulation of plastic wastes as they are non- biodegradable, some of them are non-recyclable pose a serious threat to the environment. The best way of disposal of waste plastic is its recycling to the maximum extent and many developed countries have recycled waste plastics to manufacture various products. Studies have revealed that waste plastics have great potential for use in bituminous construction as its addition in small doses, about 5-10%, by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous mix, leading to improved longevity and pavement performance. The use of waste plastic thus contributes to construction of green roads.

1.1 Objective of the Research

The specific objectives of the study can the summarized as follows.

- To determine the properties of waste plastic modified binder.
- To analyze the effect of waste plastic modified bitumen on road quality.

It is expected that the research would help to explore the potential use of waste plastic in flexible pavement construction and minimize the environmental hazards.

1.2 Benefits of Polymer Modified Bitumen

The purpose of polymer modification of bitumen is to construct durable pavement with greater stiffness and stability in Order to minimize maintenance cost. Use of polymer some time may increase cost of construction. In this case the benefit is evaluated by quality improvement of pavement. The use of RPE (recycled polyethylene) give benefits in quality improvement and cost effectiveness as well as environmental hazards.

Quality improvement of binder: Polymers in bitumen improve the following quality of bitumen:

- Polymer Increases binders viscosity that allows greater film thickness in paving mixes without excessive drain down or bleeding
- It increases the binder's qualities to better cope with cracking and dynamic deformation of the pavement internal layers.
- It improves the binder's behaviour to fatigue by increasing its mechanical resistance particularly to attractive force.
- It raises the softening point of binder that helps in reducing bleeding.
- It increases elasticity and resilience at high temperatures
- It increases the cohesion of binder.
- It reduces thermal susceptibility to both low and high temperature.
- It increases flexibility of pavement.
- It reduces deformation in pavement.
- Improved aging and oxidation resistance due to higher binder contents.
- It provides greater fatigue resistance.

- It provides improved self-healing properties.
- It provides greater durability.

1.2.1 Environmental improvement

Use of waste plastic in road construction could lead a significant consumption of waste plastic daily generated which would be helpful in, keeping the environment clean, reducing clogging of drains causing various hazards including health hazard , reducing dumping of plastic materials wastes going into land fill etc.

2. METHODOLOGY

The tests that would be performed in order to evaluate the properties of binders (pure and modified) are Penetration, Ductility. These tests would be carried out following the AASHTO/ASTM standard procedure. A brief description of these tests methods and their significance are presented here.

2.1 Penetration Test

The penetration test measures the consistency of binders. It is expressed as a distance in tenths of a millimetre that a standard needle vertically penetrates into a sample of the material under specified conditions of loading, time, and temperature. The higher value of penetration indicates softer consistency. To determine the penetration, sample should be melted properly and cooled and maintained specified temperature. The penetration is measured with Penetrometer (penetration apparatus) at standard temperature of 25ºC

2.1.1. Penetration Test Method: AASHTO DESIGNATION T 49-93 (ASTM DESIGNATION D5-86
Summary of the Method: The sample is melted and cooled under controlled condition. The penetration is measured with a Penetrometer by means of which a standard needle is applied to the sample under the specified condition.
Test Condition: The accuracy of the test result is dependent on closely controlled temperature condition. The test is performed at 25°C temperature. The test load and loading time are 100 gm and 5 seconds respectively.

Table 1 Penetration test result on various mixes of waste plastic and bitumen

Test Method	Waste Plastic Content (%)	Penetration (1/10 mm)	Penetration of Residue from LOH Test (1/10 mm)
AASHTO T49-93 ASTM D5-86	0.0 (Pure Bitumen)	70	65
	2.5	62	25
	5	43	20
	7.5	25	15

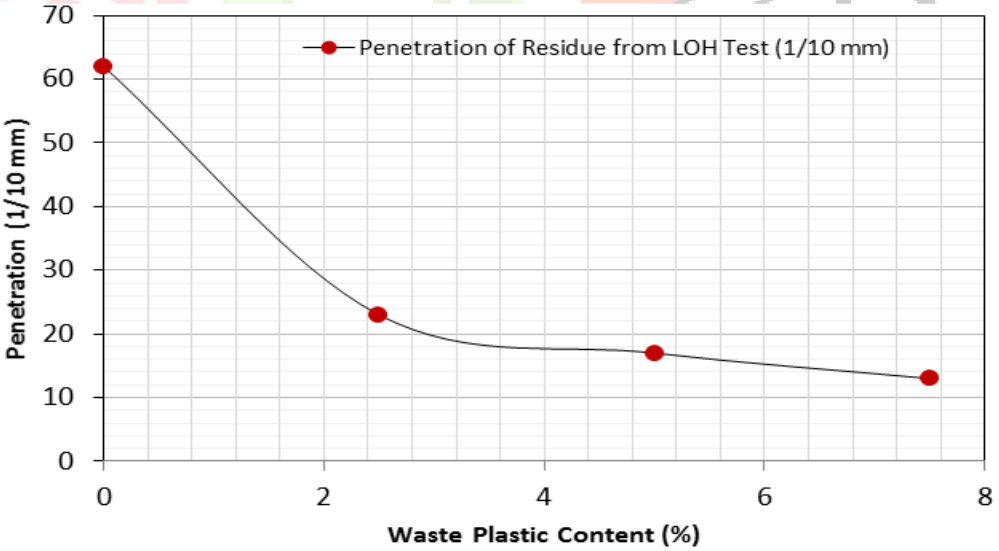

Fig 1. Penetration test result of waste plastic and bitumen

2.2 Ductility Test

Ductility is a measure of elasticity of bitumen. The ductility of paving is measured by the distance to which it will elongate before breaking or fracture when two ends of a specimen are pulled apart at a specified speed and temperature.
Ductility Test Method: AASHTO DESIGNATION T 51-93(ASTM DESIGNATION D113-79).
Summary of the Method: The sample is melted, stirred and poured into the mould as per specification. After cooling to room temperature for 30-40 minute, the excess material is cut off with a slightly straight edged putty knife. The mould is then set in the testing apparatus and ductility is measured at standard test condition.
Test Condition: Test is performed at 25°C±0.5°C temperature, at pulling rate 5 cm/minute.

Table 2 Ductility test result on various mixes of waste plastic and bitumen

Test Method	Waste Plastic Content (%)	Ductility (cm)
AASHTO T49-93 ASTM D5-86	0.0 (Pure Bitumen)	100
	2.5	33
	5	30
	7.5	20

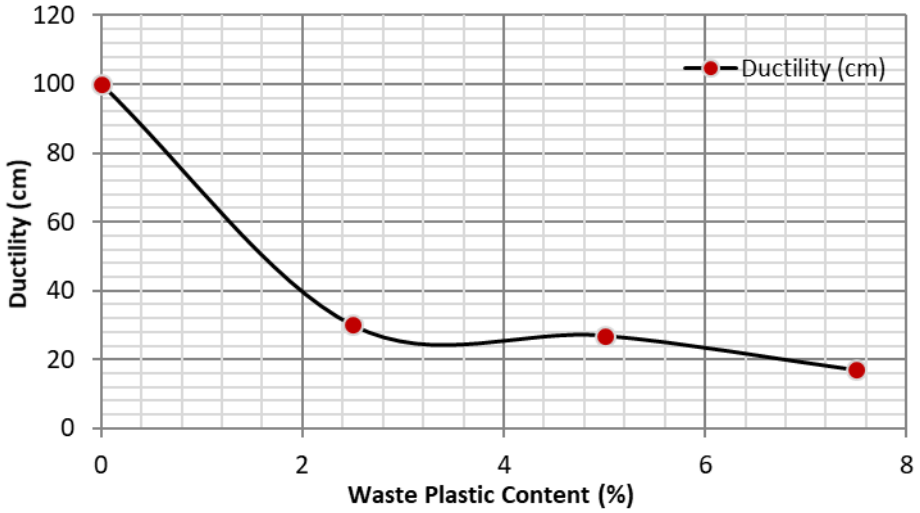

Fig 1. Ductility test result of waste plastic and bitumen

3. CONCLUSION

The rheological properties of binders (pure bitumen and modified bitumen) were evaluated by such tests as penetration and ductility. The following conclusions can be drawn by analyzing the test results on the binders:

• The penetration of the waste plastic modified binder decreases with the increase of waste plastic content in bitumen.
• The ductility of the waste plastic decreases with the increase of addition of waste plastic in bitumen.

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