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Utilization Of Waste Polyethylene Materials In Bituminous Concrete Mix For Improved Performance Of Flexible Pavements

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ABSTRACT

Over the past two decades traffic volume and percentage of heavy trucks have increased, demanding from pavement engineers stronger and long lasting pavements. In order to increase the anticipated design life of the pavement, there is a need to investigate the application of new and innovative material for extending the life of pavements. The steady increase in high traffic intensity in terms of commercial vehicles, and significant variation in daily and seasonal temperature demands improved road characteristics. Any improvement in the property of the binder is needed. This study presents a research conducted to study the behaviour of Bituminous Mix prepared with "Plastic Waste (Polyethylene) – Bitumen" blend to be used in construction of flexible pavements for effective use in road construction industry which will result in improved road pavements and also safe disposal of waste plastic in particular to urban roads.

Keywords :Waste Polyethylene, Bituminous mix, Flexible Pavements.

1.Introduction

Investigations in India and countries abroad have revealed that properties of bitumen and bituminous mixes can be improved to meet requirements of pavement with the incorporation of certain additives or a blend of additives. These additives are called "Bitumen Modifiers" and the bitumen treated with these modifiers is known as "Modified Bitumen". Modified Bitumen is expected to give 50 to 100 per cent higher life of surfacing depending upon degree of modifications and type of additives used. Polymer modified bitumen is emerging as one of the important construction of flexible pavements. The polymer modified bitumen show better properties for road construction and plastics waste can find its use in this process providing improved performance of flexible pavements and this can help solving problem of pollution due to waste plastic too.

2 Problem Statement

One of the major problems of Indian Roads is formation of Pot holes which usually occurs when vehicular loads induce shear stresses that exceed the shear strength of the materials contained in the pavement structure. This depends on vehicular loads and the visco-elastic properties of the bitumen binder. Bitumen binders are required to have high stiffness at high temperatures to resist rutting.

While talking to Environmental Pollution in recent years, numerous waste materials result from manufacturing operations, service industries and households in which several millions of plastics are produced and plastics are not being readily biodegradable will persist in the environment in a more or less unchanged state of a considerable time. The need of the hour is to use the waste plastic in some beneficial purpose. In this study an attempt was made to find solution to overcome above discussed problems.

3 Importance of the Study

Utilization of waste recycled packaging plastics is of great importance, particularlyfor bitumen conservation and for bitumen modification to find its utility in bituminous mixes for laying flexible pavements. Utilization of waste recycled packaging plastics is of great importance, particularlyfor bitumen conservation and for bitumen modification to find its utility in bituminous mixes for laying flexible pavements.

Besides, the polymer additive in bitumen is to avoid environmental problems resulting from waste plastic disposal.By using waste polymers to modify the bitumen proved to be an ideal way, not only for solving the pollution problem in our country, but also for improving the performance of bitumen.

4 Material Selection

4.1 Selected Waste Plastic

Now a days in India it is most common to see these polyethylene (here in after referred as "Polythene") materials used for packaging of drinking water in small pouches. These water pouches are very low in cost and are highly available near bus stations, railway stations, eating places and many other busy locations. After the use of water in these pouches people use to throw these unwanted polythene pouches in the surroundings which in result causes environmental pollution to the cities and other road side area. Also the disposal of these non-decaying and non-biodegradable waste polythene's is a menace for the present society.So, Plastics used in the experiments were polythene material (LDPE) of these water pouches and other packing goods collected from the mixed plastics wastes along the road side, figure. 1.

4.2 Selected Bitumen Grade
The selected bitumen penetration grade for this study was 60/70 usually used as a Paving Grade Bitumen suitable for construction of flexible pavements with superior properties.

4.3 Aggregates and Mineral Filler
Aggregate constitutes the granular part in bituminous concrete mixtures which contributes up to 90–95% of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture. Hence, the quality and physical properties of the aggregates should be controlled to ensure a good pavement.The aggregates of different grades were sieved through different IS Sieves and they were kept in different containers with proper marking. Aggregates used for mix were of two types: Coarse Aggregate and Fine Aggregate. The mineral fillers may be cement or fly ash.

5 Sample Preparation
5.1 Waste Polythene – Bitumen Blend
The collected polythene wastes were washed, cleaned and dried. The polythenes were then shredded into very tiny pieces. The required quantities of polythene to be added with specified amount of bitumen for preparation of different percentage of polythene-bitumen blend were weighted andadded in required percentage by weight of bitumen to the hot bitumen and the mixture was stirred well for about 30 minutes under temperature around 170-180°C.

5.2 Marshall Mould
The aggregates of different grades were sieved through different IS Sieves and they were kept in different containers with proper marking.The mixing of materials required for mould preparation was done as:Required quantities of coarse aggregate, fine aggregate & mineral fillers were taken in an iron pan.This was kept in an oven at temperature 160 °C for 2 hours. This is because the aggregate and prepared blends are to be mixed in heated state so preheating is required.The prepared blend was also heated up to its melting point prior to the mixing.The aggregates in the pan kept in oven were taken and heated on a controlled gas stove for a few minutes maintaining the temperature.Now blend (60 gm.), i.e. 5% was added to this mix and the whole mix was mixed uniformly and homogenously. This was continued for 15-20 minutes till they were properly mixed.Then the mix was transferred to the Marshall sampling mould.The mix in the mould was then compacted by the Marshall Hammer. 75 numbers of blows were given on each side of the sample so a subtotal of 150 no. of blows was given per sample.Then these samples with moulds were kept separately and marked accordingly to the percentage of polythene added by weight of bitumen.

6 Physical Values of Polythene Modified Bitumen
The values for physical properties of Polythene Modified Bitumen tested through experiment are given in table 1. Below:

Table 1 Physical Properties of Modified Blend

Properties	P0 0% Plastic	P1 1% Plastic	P2 2% Plastic	P3 3% Plastic	P4 4% Plastic	P5 5% Plastic
Softening Point(ºC)	47.5	50.0	51.4	53.0	55.0	55.9
Penetration Value (mm)	65.0	55.0	50.0	48.5	46.0	44.0
Ductility (Cm)	100	100	90	85	78	56
Flash & Fire Point (ºC)	>280	>350	>350	>350	>350	>350

7 Marshall Stability and Marshall Flow Value
The effect of polyethylene admixture on the volumetric properties of both modified and conventional bituminous mixes are shown in table 2 & figure 2 below:

Sample	MSV (Kg)	Flow (mm)
P0	1401	2.93
P1	1518	2.77
P2	1614	2.63
P3	1713	2.43
P4	1881	2.37
P5	1613	2.23

Table 2 MSV & Flow Value

Figure 2 MSV V/s Polythene Content

8 Result Analysis
The desired properties of bitumen binders were improved by introducing polythene as an additive. This process of modification of bitumen with waste polythene has enhanced resistance to cracking, pothole formation and rutting by increasing softening point, hardness and reducing stripping due to water, thereby improving the general performance of loads over a long period of time.It observed that Marshall Stability value increases with polyethylene content upto 4% and thereafter decreases. We observe that the Marshall Flow value decreases upon addition of polythene i.e the resistance to deformations under heavy wheel loads increases.

9 Conclusion
The results indicated that the utilization of waste polythenes in bituminous concrete mixtures shows improved property of the mixtures thus formed.The waste polythene utilized in the mix will get coated over aggregates of the mixture and reduces porosity, absorption of moisture and improves binding property. The bitumen modified with 4% Polythene Waste is showing better performance as compared to other mixes. The Marshall Stability which is a strength parameter has shown increasing trend with a maximum increase percent of 34.26% as compared to Conventional mix when modified with 4% Polythene Waste. It is observed that Marshall Stability value increases with polythene content upto 4% and thereafter decreases. Thus the use of higher percentage of waste polythene is not preferable.While talking to environmental pollution due to these non-biodegradable plastics waste where disposal of such materials has become a serious problem, its use in construction of flexible pavement will give a better place for their burying and thus solving the problem of their disposal on one hand and providing a better flexible pavement with improved performance on other hand.

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