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NUMERICAL INVESTIGATION OF MODIFIED BITUMINOUS MIX FOR DBC USING WASTE POLYTHENE

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ABSTRACT

Now a day, in India as the result of rapid industrial growth in various fields with high population growth an obvious an increase the consumption of polythene. Disposal of largely consumed plastics causes an environmental pollution as they are considered non-biodegradable materials. The objective of this experimental study was partially replacement of polythene wastes mixing with asphalt bitumen in road construction to improve the performance (quality) of the road and to minimize the cost of bitumen spend for road construction in addition to solving disposal problems. The experimental study began with a collection of waste plastics. The waste plastics then washed, dried and cut into desired shapes. Bitumen test, aggregate test, and marshal mix design were held during the study.

KEYWORDS: LDPE, DBC, Bituminous Mixes, Waste Polythene, Flexible Pavement etc.

I. INTRODUCTION

Plastics are durable & non-biodegradable; the chemical bonds make plastic very durable & resistant to normal natural processes of degradation. Since 1950s, around 1 billion tons of plastic have been discarded, and they may persist for hundreds or even, thousands of years. The plastic gets mixed with water, doesn't disintegrate, and takes the form of small pallets which causes the death of fishes and many other aquatic animals who mistake them as food materials.

Today the availability of the plastic wastes is enormous, as the plastic materials have become the part and parcel, of our daily life. Either they get mixed with the Municipal

Solid Waste or thrown over a land area. If they are not recycled, their present disposal may be by land filling or it may be by incineration. Both the processes have significant impacts on the environment. If they are incinerated, they pollute the air and if they are dumped into some place, they cause soil & water pollution. Under these circumstances, an alternate use for these plastic wastes is required.

The use of plastics in various places as packing materials and the products such as bottle, polythene sheet, containers packing strips etc. are increasing day by day. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mixed used in the surfacing course of roads. This results in production of plastic waste from all sort livings from industrial manufactures to domestic users. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low – temperature cracking of the pavement surfacing.

Road surface with neat bitumen can cause bleeding in hot climate, may develop cracks in cold climate, possess fewer loads bearing capacity and can cause serious damages because of higher axle load in present conditions due to rapid infrastructure development.

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Modification of BC, with the synthetic polymer binder can be considered as a solution to overcome the problems, arising because of the rapid increase in wheel loads and change in climatic conditions. Polymer modification can be considered as one of the solution to improvise the fatigue life, reduce the rutting & thermal cracking in the pavement. Asphalt, when blended or mixed with the polymer, forms a multiphase system, containing abundant asphaltenes which are not absorbed by the polymer. This increases the viscosity of the mix by the formation of a more internal complex structure.

II. LITERATURE REVIEW

(I) Kazmi and Rao (2015) Studies are reported in the present work to focus on blending of waste plastic materials (in the form of shredded polyethylene bags) being used as a binding agent in asphalt for road construction. This study compared the results with the standards set by Oman as per MOTC (Ministry of Transportation & Communications) guidelines for asphalt as a road laying material. Polyethylene was used as a binding agent along with bitumen (60/70) grade and dolerite as the aggregate material. The studies showed that not only did the road become a receptacle for plastic waste, but it also had a better strength and durability which were verified by determining the bulk density, stability test, flow test and the density and voids analysis. The experiments have showed that 9 % of low density polyethylene to be an effective binder proportion of polyethylene by weight of bitumen which were in agreement with previous studies. With a stability value of 1590.2 kg, it was 32.5% greater than the standard of a minimum 1200kg; and a flow value of 2.9-3.0 mm was well within the required range. The specific gravity of the material was 2.446. The VMA (voids in mineral aggregate) was 5% while the given range was 4-7%, and the air voids were up to 66.7% showing that it was well within the standard range of 50-70% as per MOTC standards.

(II) Apurva J Chavan (2013) Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. In my research work I have done a thorough study on the methodology of using plastic waste in bituminous mixes and presented the various tests performed on aggregates and bitumen.

(III) Bhatt and Gupta (2017) Bituminous Concrete (BC) normally used in construction projects like road surfacing, airports, parking lots etc is a composite material. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together & laid down in layers then compacted. In these days the large increment in high traffic intensity in terms of commercial vehicles, and the compelling variation in daily and seasonal temperature put us in a demanding situation to think of some alternatives for the improvisation of the pavement characteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspects. Also considering the environmental approach, due to excessive use of polythene in day to day life the pollution to the environment is increased significantly. Since the polythene is non-biodegradable the need of the current hour is to use the waste polythene in some beneficial purposes .This paper presents a research conducted to analyse the behaviour of BC mix modified with waste polythene. Various percentages of polythene are used for preparation of mixes with a selected aggregate grading as given in the IRC Code. By preparing Marshall, samples of the concrete mix the role of polythene in bituminous is studied for various engineering properties BC mixtures with and without polymer. Marshall, properties such as stability, flow value, unit weight, air voids are used to determine optimum polythene content for the given grade of bitumen (80/100).

(IV) Suliman (2015) this study is an aim to investigate experimentally the influence of waste plastic PET on design and properties of asphalt concrete (AC). Asphalt concrete modification with plastic as bitumen modifier improves temperature susceptibility. Present study was purposed to design asphalt concrete with plastic as modified bitumen. The objectives of this study were to design the AC with waste plastic bottle as bitumen modifier, to assess the AC properties modified with waste bottle plastic and compare it with unmodified AC. AC was modified with 6% plastic as bitumen modifier.

III. OBJECTIVES

In the present work focus is on flexible roads made of bitumen, as they comprise majority of the roads in India. It has been possible to improve the performance of bituminous mixes used in the surfacing course of road pavements, with the help of various types of additives to bitumen such as polymers, rubber latex, crumb rubber-treated with some chemicals, etc. In this work, use LDPE (Low Density Polyethylene Such as Waste Plastic Bags) as modifiers to improve the physical properties of bitumen. The study is further resulted to utilization of LDPE in higher percentage in DBC.

The scope of the study includes the following:

1. Determination of optimum binder content of bituminous mix for DBC.
2. Determination of Physical Properties of bituminous mix modified with varying dosage of LDPE modifier.
3. Selection of optimal dosage of LDPE modifier for modification of bitumen.

IV. METHODOLOGY

Laboratory experiments were conducted on the conventional bitumen (80/100) and modified bitumen samples. Individual properties (Penetration, Softening Point, Ductility, Flash and Fire, and Specific Gravity) of the sample were determined. Using the Marshal Mix design characterization of conventional bituminous mix (80/100) for dense bituminous mix (DBC) were carried out and comparison was made for conventional bitumen mix properties with modified bitumen. After determining factors to be considered for modelling modified bitumen in bituminous mix, a detailed plan for the experimental program (sample preparation and lists of tests) was developed.

Following tests were conducted:

1. Penetration test
2. Ductility test
3. Softening point test
4. Specific gravity test
5. Flash and fire point test
6. Marshal stability test

The above listed tests were conducted on the following conventional/modified bituminous samples with LDPE.

Table 4.1 Details Of Samples And Modifier

Sample Constitution	**Sample Preparation**	**% Bitumen content + % Modifier (LDPE) by weight of Bitumen**
80/100 Grade bitumen	**Wet Process**	5.0 + nil
		5.25 + nil
		5.5 + nil
		5.75 + nil
		6.0 + nil
Bitumen + LDPE	Dry process	OBC + 1% LDPE
		OBC + 2% LDPE
		OBC + 3% LDPE
		OBC + 4% LDPE
		OBC + 5% LDPE
		OBC + 6% LDPE

V. CONCLUSIONS

Conclusion resulting from the present study is presented in this paper, the following this conclusion has been drawn from the study.

1. Optimum binder content for Dense bituminous mix prepared with 80/100 grade bitumen is found to be 5.5% with maximum Marshall Stability Value of 905 Kg.
2. DBC prepared using LDPE as partial replacement of bitumen shows significant increase in Marshall Stability Value.
3. An increase of 8% (980 Kg) to 33% (1206 Kg) is recorded in Marshall Stability Value for variable doses of modifier (LDPE).

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4. Optimum Polythene content obtained using marshal stability test is 4%.
5. Flow value and VFB increases while Air Voids decreases with the increase of percentage modifier.

For a country like India, where hot temperature prevails in summer in several parts, permanent deformation of bituminous layer is a major concern. This problem can be addressed by adopting courser gradation for wearing course. In the Marshall stability value increases with polyethylene content up to 4% and thereafter decreases. This small investigation not only utilizes beneficially, the waste non-degradable plastics but also provides us an improved pavement with better strength and longer life period. Polymer modified pavements would be a boon for India's hot and extremely humid climate, where temperatures frequently rises past 50°C and torrential rains create havoc, leaving most of the roads with heavy distresses.

Further investigation may carry out using different grade of binder with more flexibility in selection of polythene content.

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