

Review Paper on Experimental Study on Use of Plastic in Flexible Pavement

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Abstract – Nowadays the disposal of plastic waste is one of the greatest problem faced by us. It is started attracting public attention due to the various environmental and health hazards. Every year million metric tonnes of plastic produced in India. At the same time we are facing issues of failure of roads due to lack of properties and no timely maintenance. This review paper prepared by studying previously published research paper on use of waste plastic in flexible pavement. It also deals with the properties of polymer modified bitumen and application of plastic by wet process. This paper reviewed the polymers like Low Density Polymer (LDPE), High Density Polymer (HDPE), Polypropylene, Polystyrene which can be safely used in flexible pavement without causing environmental hazards. Titanium Dioxide is used as Smoke Absorbent. This review paper have also covered some major issues like leaching of soil, formation of HCL gas, breakdown of plastic into microplastics which may enter into soil or water.

Key Words: Polymer Modified Bitumen, Wet Process, Titanium Dioxide, Low Density Polymer (LDPE), High Density Polymer (HDPE), Polypropylene, Polystyrene.

1. INTRODUCTION

Today every sector around the world from agriculture to electrical, packing, automobile, building construction, communication sector are widely using plastics. The usage was started after the industrial revolution and its large scale production seemed to be cheap. Generally plastic is the non-biodegradable and many research found that plastic takes around 4500 years to degrade. Several studies proven that the disposal of plastics causes many health and environmental problems and also reduces the fertility of soil. The plastic production over the world has crossed 400 million tons and the recycling of plastics is only 10%. On other hand we are facing problem of failure of roads due to edge cracks, pot holes, insufficient strength properties of bituminous mixes, movement of over loading vehicles, bad drainage conditions and due to lack of properly and timely maintenance.

Various experiments are being conducted in order to improve the properties of bituminous roads. The recent advancement in that study is use of waste plastic in road construction. The use of plastic in road construction is gaining importance nowadays due to performance, life span and low construction cost. The polymers used for the

mix are Low Density Polyethylene (LDPE) i.e High Density Polyethylene (HDPE), Polypropylene, Polystyrene without causing environmental hazard. Low Density Polyethylene is clear or translucent plastic exhibits flexibility, chemical resistance, and waterproofing capabilities. High Density Polyethylene (HDPE) offers greater resistance and durability. Polypropylene when used for construction it can withstand higher temperature and load. The coating of plastics reduces porosity, absorption of moisture and improves soundness. Polystyrene is light weight, moisture resistant, versatile, and it increases durability, thermal efficiency and it is environment sustainable.

1.1 MIX PROCESS

The mixing will be done by wet process. For wet process 60 micron or below size plastic is preferred. The reason behind this is that less size of plastic can easily mixable with hot bitumen at temperature between 160°C -170°C. Then hot mix is cooled up to 120°C into another chamber which is then added to the aggregate in paddling chamber. After addition of modified bitumen at 110°C on aggregate, the mix is prepared for marshal stability test.

1.2 COMPOSITION

After a lot of research we found that the composition of plastic roads mainly depends on the percentage of plastic used, grade of bitumen and size of aggregate. It is found that most of paper suggested to use an aggregate of size 10mm -20mm. 60/70, 80/100 grade of bitumen and maintaining the laying temperature between 110°C to 120°C. As the percentage of plastic increases softening point, flash point and fire point increases whereas penetration value and ductility decreases. The porosity should be less than 2%. Due to this porosity the air is accumulated in bitumen and it causes oxidizing of bitumen. This makes bitumen hard. The coating of plastic reduces the porosity. Also stone dust and lime are used as filler materials. The Impact value and Los Angeles abrasion value decreases with increase in percentage of plastic. Also Titanium Dioxide is used as smoke adsorbent in pavement to absorb vehicle smoke. Also we will alter the percentage of plastic to check suitability.

2. LITERATURE REVIEW

Amit Gawande et.al. The author have published journal on "An overview on waste plastic utilization in asphaltting of

roads". This paper describes the use of plastic in bitumen to improve desired mechanical for the flexible road. This paper review important techniques for using waste plastic in construction flexible pavements and bituminous road. Researchers collect more data on plastic consumption and the generation of plastic waste. Also, this paper describes the properties and characteristics of bitumen and plastic. This paper gives detail information about the wet and dry process. The final conclusion of this paper is modified bitumen is better for the upper layer of flexible pavement, and modified bitumen shows more resistant to water, stability, load carrying capacity and better binding property.

Zahra Niloofar Kalantar et.al. Researcher have described the adding of virgin polymer in bitumen for improving properties of bitumen. More additions of the virgin polymer have the same result as compare to waste polymer according to historical study. This paper review of the virgin also wastes polymer in the pavement with help of study on the history of use of polymer in asphalt, benefits of using polymer in asphalt, use of polymer waste into the virgin polymer. A benefit of using polymer in asphalt section describes the major improvement.

Tapase Anand et.al. Author have studied, "Performance Evaluation of Polymer Modified Bitumen in Flexible Pavement". The work consists of an experimental approach towards waste management and finding an alternative to conventional materials in flexible pavements. To simulate with the field conditions the Marshall Stability method is considered to carry out experimental work. The objective of work is to investigate the effect of plastic waste in flexible pavement and to suggest the optimum percentage of bitumen that can be replaced by plastic waste for the improvement of roads. The number of laboratory tests has been carried out by replacing bitumen with plastic waste. The results obtained in laboratory investigation indicate a major gain in strength with substantial savings in cost.

Sui Yuanyuan et.al. This paper deals with the mixing or adding method of polyethylene modifying additive in different from asphalt modifier. The method of research is mixing the Polyethylene as modifying additive in the mineral aggregate for some minutes and then adds the asphalt mixing in polyethylene and aggregate. This method is different from the regular asphalt modifier. This paper mainly described the improvement in asphalt mixture when it is mixed with polyethylene modifying additive on higher temperature stability, resistance at low temperature cracking and water resistance is obviously, analyze the mechanism that additive affect asphalt mixture performance and evaluate polyethylene modifying additive on the basis of technical, economic and environmental aspects. Also, researchers explained about High-temperature Stability and Low temperature Performance, Water Stability is weak in bitumen. The conclusion of this research paper is improving the quality of bitumen. (i.e. maximum temperature stability and low-temperature performance, water stability) by mixing polyethylene modifying additive.

S. Dombe et.al. This paper have described partial replacement of bitumen with plastic by the wet mix process. A number of laboratory tests were conducted using the Marshall Stability testing machine to check the suitability of e-waste and plastic as an alternative to conventional materials like aggregates and bitumen respectively. The results obtained in laboratory investigation indicate not only the increase in strength but also a considerable reduction in cost is seen. From the experimental work, it is clear that the properties of laboratories designed bituminous mix for DBM are much more superior to those of the control mixes entirely composed of mineral aggregates and can be effectively used in practical applications.

Rishi Singh Chhabra et.al. Stated that, In the highway infrastructure, a large number of originates materials and technologies have been invented to determine their suitability for the design, construction and maintenance of these pavements. Plastics and rubbers are one of them. The use of plastic materials such as carry bags, cups, etc. is constantly increasing day by day. Since the polythene are not biodegradable, the need of the current hour is to use the waste polythene in some beneficial purposes. The use of these materials as a road construction proves eco-friendly, economical and use of plastic gives strength in the sub-base course of the pavement.

C.E.G. Justo et.al. States that addition of 8.0 % by weight of processed plastic for the preparation of polymer modified bitumen results in a saving of 0.4 % bitumen by weight of the mix or about 9.6 kg bitumen per cubic meter of BC mix. Modified Bitumen improves the stability or strength, life and other desirable properties of bituminous concrete mix.

Sabina et.al. Studied the comparative performance of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by weight of bitumen) with conventional bituminous concrete mix (prepared with 60/70 penetration grade bitumen). Improvement in properties like Marshall Stability, retained stability, indirect tensile strength and rutting was observed in Plastic modified bituminous concrete mixes.

Bhageerathy et al. Investigated the use of biomedical plastic waste in bituminous road construction. They concluded that the Marshall stability value of plastic modified mix was found to be 51 percent more than that for the normal mix which indicates an increase in load carrying capacity.

Johnson Kwabena Appiah et.al. This paper is useful mainly to solve two main problems in India. firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes on roads due to excessive traffic and axle weight. This study examines the effect of blending waste thermoplastic polymers, namely High density polyethylene (HDPE) and Polypropylene (PP) in Conventional AC-20 graded bitumen, at various plastic compositions. The plastics were shredded and blended with the bitumen in-situ, with a shear mixer at a

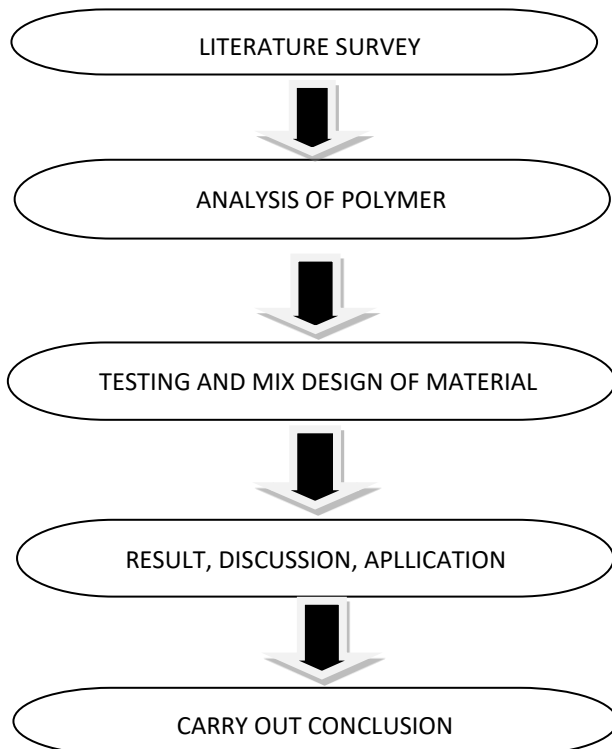
temperature range of 160°C–170°C. Basic rheological parameters such as penetration, ring & ball softening point and viscosity tests were employed to determine the resulting changes from base bitumen. It was observed that polypropylene polymer, showed profound effect on homogeneity and compatibility with slight linear increment in the viscosity, softening and penetration values as against relatively high changes for HDPE modified bitumen.

3. LITERATURE GAP

We found that lots of research paper have failed to find solution on major issues caused due to plastic road like formation of HCL gas, leaching of soil, breakdown of plastic into microplastics due to heavy axle load which may enter into soil or water. Hence, we tried to solve this problem by providing eco-friendly and economical solutions.

4. METHODOLOGY

In our project we will use polymer modified bitumen in flexible pavement to improve the life span of road without sacrificing durability and with cost reduction. We have tried to find solution on major issues due to plastic road without disturbing environmental balance. The following flowchart illustrate the methodology adopted to proceed towards completion of our project.



5. CONCLUSION

After studying the above mentioned research paper we have made conclusion that

- According to IS SP-98 2003 Low Density Polymer (LDPE), High Density Polymer (HDPE), Polypropylene, Polystyrene are best suited polymer to plastic road due to their enhancing properties.
- For mixing i) Dry Process ii) Wet Process one of this two process is used.
- Polymer Modified Bitumen is used due to its better performance. The plastic coated bitumen helps in binding strength and increases the area of contact between the aggregate and bitumen.
- It also helps in elimination of voids. Due to the elimination of voids, road shows the resistance towards the oxidation of bitumen by entrapped air. This property makes the plastic coated bitumen road to withstand heavy traffic.
- Research papers also proved that plastic roads are not only increases the quality but also make it economical and reduces maintenance.

6. REFFERENCES

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