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Paving the Way for Sustainable Infrastructure: Plastic Coated Aggregates in Bituminous Mixes for Flexible Pavements

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ABSTRACT

The use of Plastics in day to the life occur serious environment pollution such as soil pollution, water pollution, and air pollution. The plastic is as non-decaying waste material and result in pollution. To avoid such harmful environmental issues its need to make proper management regarding recycling and reuse of plastic. The present work covers Utilization of plastic coated aggregate in bituminous mix for flexible pavement. In this study to find out mechanical properties on aggregate and Marshall Stability Test for mix design of flexible pavement for 0%, 5% and 7% plastic coated aggregate. It helps increases road performance and also finds a way for safe disposal of plastic wastes in order to counter environmental pollution as well.

Keywords: Plastic Coated Aggregate (PCA), Marshall Stability Test

I. INTRODUCTION

India, as a rapidly developing country, is facing a significant challenge in managing the increasing amount and diversity of waste generated. Much of the waste produced today, including plastics, persists in the environment for hundreds, if not thousands, of years, contributing to pollution. Recycling plastics and incorporating them into construction materials offer a valuable opportunity to address the issue of plastic waste disposal.

In the construction industry, recycling plastics for use in concrete is emerging as a particularly promising application. Research into innovative uses of waste materials is ongoing worldwide, focusing on finding solutions that are both environmentally friendly and economically viable. Many highway agencies, private organizations, and individuals are conducting studies and research projects to assess the feasibility, environmental impact, and performance of incorporating waste plastics into highway construction.

These efforts aim to align the societal need for safe and cost-effective waste disposal with the requirements of the highway industry for environmentally friendly construction materials. Plastic possesses several properties that make it suitable for enhancing bituminous concrete mixes used in pavement construction, including durability, corrosion resistance, cost-effectiveness, and potential noise pollution reduction.

By leveraging these properties, integrating recycled plastics into pavement construction can lead to longer-lasting, more economical, and environmentally sustainable road infrastructure.

II. METHODOLOGY

To find out properties of plastic coated aggregate following are the implementation would be taken.

- To comparative study the various engineering properties of plastic coated aggregate and normal aggregate.
- To find out Optimum Bitumen Content using Marshal Mix design procedure.
- To discuss the test result and find out conclusions.

Materials Used:

- Aggregate: 20mm, 10mm,
- Bitumen: A35 grade bitumen
- Waste Plastic: Waste plastic in the shredded form, stone dust and cement as filler.

Understand the scientific terms and jargon related to your research work.

III.RESULTS AND DISCUSSION

A. Test on Aggregate

The Physical properties of the aggregates were tested in laboratory. To check the aggregate with plastic coat and without plastic coat from the test result we found that the selected aggregate is within the specified range for hot asphalt mix design.

TABLE I PHYSICAL PROPERTIES OF AGGREGATES CONVENTIONAL (0% PLASTIC) AND PLASTIC COATED AGGREGATE (PCA)

Description of tests	Percentage of Plastic used			Specifications IRC:111-2009
	0%	5% (PCA)	7% (PCA)	
Aggregate Crushing strength	15.86%	13.9%	11.4%	Max 30 %
Impact value	14.33%	13.9%	11.6%	Max 24%
Specific gravity	2.78	2.73	2.75	2.5-3.0
Los Angeles Abrasion value	18.82%	14.8%	11.2%	Max 30%
Flakiness Index value	9.2%	13.8%	12.6%	Max 35 %
Elongation index value	11.5%	11%	11.2%	Max 35 %
Water absorption value	0.99%	0.67%	0.34%	Max 2%

B. Marshall Mix Design

The main object of Marshall Mix Design is to make durable and economic mix with proper gradation of aggregate and adequate proportion of bitumen so as to fulfill the desired properties of the mix bituminous concrete. In this method, the resistance to plastic deformation of a compacted cylindrical specimen of bituminous mixture is measured when the specimen is loaded diametrically at a deformation rate 53 of 50 mm per minute. There are two major features of the Marshall method of mix design.

- Density-voids analysis
- Stability-flow tests.

The Marshall stability of the mix is defined as the maximum load carried by the specimen at a standard test temperature of 60°C. The flow value is the deformation that the test specimen undergoes during loading up to

the maximum load. Flow is measured in 0.25 mm units. In this test, an attempt is made to obtain optimum binder content for the type of aggregate mix used and the expected traffic intensity.

Marshall Stability is related to the resistance of bituminous materials to distortion, displacement, rutting and shearing stresses. The stability is derived mainly from internal friction and cohesion. Cohesion is the binding force of binder material while internal friction is the interlocking and frictional resistance of aggregates. As bituminous pavement is subjected to severe traffic loads from time to time, it is necessary to adopt bituminous material with good stability and flow.

In this study found following test result.

TABLE III MARSHALL TEST RESULTS

Sr No	% Bitumen by Weight of Total Aggregate Mix	Theoretical specific gravity (G mm)	Bulk specific gravity (G mb) g/cm³	% of Air voids (Vv)	% of voids filled with bitumen Air voids (VFB)	Marshall Stability Value (Kg)	Flow value (mm)
1	0	2.60	2.39	8.07	56.09	1688	4.52
2	5	2.52	2.36	6.34	74.36	1724	4.10
3	7	2.51	2.34	6.77	75.18	1738	3.30

From the test carried on normal and coated aggregate it was observed that the maximum value of Marshall Stability was observed at plastic coated aggregate content of 7%. It is shown that plastic coated aggregate give better result than convention aggregate. It reduces environmental impact. Also give solution on disposal problem of plastic

IV. CONCLUSION

The utilization of plastic coated aggregates in the construction of flexible pavement is the give solution to disposal of plastic. From the performance of test on aggregates coated with different amount of percentage of plastic, the following conclusions are drawn:

- Coating aggregates with waste plastic reduces moisture absorption, as evidenced by lower impact values and aggregates crushing values compared to conventional aggregates without plastic.
- There is a slight decrease in specific gravity values with increasing plastic content in the aggregates
- Comparison of Marshall Stability values between conventional mixes and those containing plastic-coated aggregates revealed improved performance with 7% replacement of conventional aggregates with plastic-coated ones.
- The test results suggest that incorporating waste plastic into aggregates enhances their performance, indicating a promising solution for both waste disposal and pavement construction

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