

Study of Performance of Plastic Waste in Flexible Pavement

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Abstract - The objective of this study is to investigate the effect of plastic waste as a partial replacement of bitumen on the strength parameters of flexible pavement road. In this project we replace bitumen content by 5%, 5.5%, 6% with plastic waste 10%, 15%, 20%. Attempt is made to use the waste product like plastic bottle, glass, bags, polyethylene film, plastic straw in flexible pavement construction which affect the environment and difficult to process Marshal stability test is done to obtain the desired properties like stability, flow value, bulk density and voids analysis in the flexible pavement structure. The study concludes that the plastic waste could be used in flexible pavement by partially replacing the bitumen. In this work when bitumen content is 5.5% and plastic waste is taken as 10% of maximum stability value is obtained as 19.951KN and 15% plastic waste and 5% bitumen content gives optimum flow value is 5.625mm.

Key Words: Plastic Waste, Flexible pavement, Marshal Stability, Flow value, Bulk Density & Voids analysis.

1. INTRODUCTION

At the current condition in world various types of huge quantity of plastics generated, plastic waste is also increasing more and more per year. Plastic waste is one of the major non-biodegradable products, due to this great impact over the environment pollution.

In India 62Mtonnes of waste is generated annually out of which 5.6 M tones having plastic waste and studies reveal that 0.6M tones plastic waste discarded into ocean in urban areas. The accumulation of plastic waste on land it spoil the environment as well as hazardous to animals.

Many researchers have made study over the use of plastic waste in flexible pavement construction successfully.

Plastic is having better binding property in its molten state and gives excellent binding property to the bituminous pavements. Due to using of plastic in pavement construction pollution and cost effective work can be carried out.

2. OBJECTIVE OF THE STUDY

- To identify the optimum proportion of waste plastic to be added in the bitumen mix for getting the required strength.
- To compare the experimental results with the conventional pavement details and perform the economic analysis.

- To prepare statistical sample for optimum utilization of plastic waste.

3. MATERIALS AND METHODS

Different types of plastic wastes are used like, films (Carry bags, cups) up to 60 μ thickness, Hard foams (PS) any thickness, Soft foams (PE&PP) any thickness, laminated plastic up to 60 μ thickness.

3.1 Methods of preparation of plastic wastes.

Following some basic process involved the process of plastic waste in flexible pavement construction process.

1. Segregation
2. Cleaning
3. Shredding Process

3.2 Dry Process

Aggregate are weighed and are heated to 160 degree Celsius in pan, Shredded plastic is added to the hot mix. The plastic gets softened and coated over the surface of the aggregate in 30 - 60 seconds and Hot Bitumen (heated up to a maximum of 160°C) is added immediately and the contents are mixed thoroughly.

3.3 Wet Process

Waste plastics by direct mixing with hot bitumen at 160°C, Mechanical stirrer is needed Addition of stabilizers and proper cooling. Since the wet process requires a lot of investment and bigger plants they are not commonly used.

3.4 Tests for aggregate

The tests for aggregates involves Sieve Analysis of Aggregates, Specific Gravity and Water Absorption Test [IS: 2386 (Part 3) 1963], Aggregate Impact Value Test [IS: 2386 (part 4) 1963], Aggregate Crushing Value [IS: 2386 (Part 4) 1963], Flakiness and Elongation Index Test [is: 2386 (part 1) 1963].

3.5 Tests for bitumen

Various penetration test for bitumen includes Penetration Test [Is: 1203-1978], Softening Point Test [Is: 1205-1978], Ductility Test [IS: 1208-1978], Viscosity Test.

Table -1: Test Results on Aggregate

Name of the Test	IS Code	Permissible value as per code	Result
Impact Values Test	IS: 2386-1963 (Part-IV)	<30(For WMM) <24(For B C)	12.5 %
Crushing Values Test	IS: 2386-1963 (Part-IV)	<30(For WMM) <24(For B C)	19%
Loss Angel Abrasion test	IS: 2386-1963 (Part-IV)	<40%	24%

Table -2: Test Results on Aggregate

Name of the Test	IS Code	IS Code Standards	Result
Penetration Test	IS: 1203:1978	VG30= 45-50	47.3mm
Softening Point	IS: 1203:1978	VG30= 47-50	49.50 ^o c
Specific Gravity	IS: 1203:1978	0.99-1.02	1.001

4. RESULTS AND DISCUSSION

In this study bitumen is replaced by 5%, 5.5% & 6% and plastic content is used in this study is 0%, 10% 15% & 20%. The test conducted on marshal and flow value of bituminous. Test results plotted between the various % of plastic waste and bitumen content.

Table -3: Marshal Stability & flow value Results

Bitumen Content	Plastic Content	Marshal Stability value (kg)	Flow Value in mm
5.0%	0%	1586.52	3.625
5.0%	10%	1997.15	4
5.0%	15%	1642.52	5.625
5.0%	20%	1567.86	3.5

Table -4: Marshal Stability & flow value Results

Bitumen Content	Plastic Content	Marshal Stability value (kg)	Flow Value in mm
6%	0%	1549.19	4.625
6%	10%	1866.5	4.75
6%	15%	1586.52	5.25
6%	20%	1549.19	4.125

Table -5: Marshal Stability & flow value Results

Bitumen Content	Plastic Content	Marshal value (kg)	Flow Value in mm
5.5%	0%	1642.51	4
5.5%	10%	2034.48	3.125
5.5%	15%	1698.51	4.375
5.5%	20%	1511.86	3.75

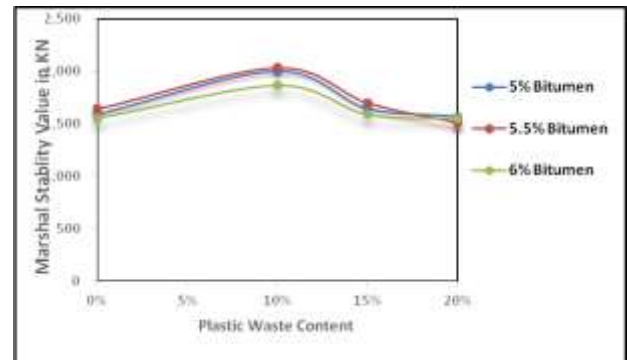


Fig.1 Marshal Stability values compared with Plastic waste.

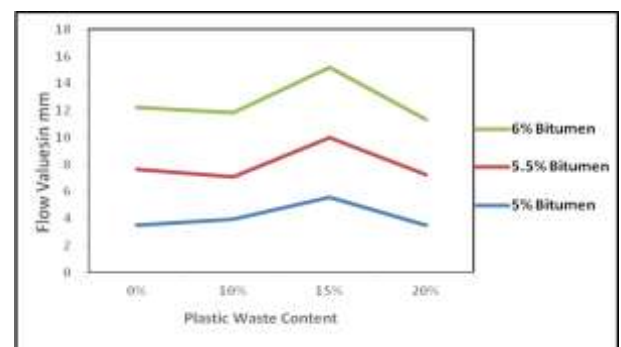


Fig-2 Flow values compared with Plastic waste.

5. ECONOMIC ANALYSIS:

Material cost comparison for 1km road:

Description	Unit	Rate/unit	For control mix		For modified sample	
			Quantity	Amount(Rs)	Quantity	Amount(Rs)
Material						
Aggregate	Ton	597	545.08	325400.53	495.85	295905.05
Bitumen	Ton	35000	31.78	112380	25.35	1069750
Plastic waste	Ton	6000			2.888	17310
Total material cost				3437700.88		1322865.05

Total material cost reduction= 7.9%

6. CONCLUSION:

- The addition of waste plastic modifies the properties of bitumen.
- The modified bitumen concrete shows good result when compared to standard results.
- The optimum content of waste plastic to be used is between the ranges of 5% to 15%.
- The problems like bleeding are reduce in hot temperature region.

- The waste plastics thus can be put to use and it ultimately improves the quality and performance of road.
- Total material cost of the project is reduced by 7.99%(refer economic analysis).

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