

Enhancement of Strength of Bituminous Pavement by Using Waste Plastic as a Ingredient Material

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ABSTRACT: Plastics are everywhere in today's lifestyle and are growing rapidly throughout particularly in a developing country like India. Waste plastics are burnt for apparent disposal which cause environmental pollution. As these are non-biodegradable material there is a major problem posed to the society with regard to the management of these solid wastes. 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 and cut into a size such that it passes through 4.75-2.36mm 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 in wearing course in flexible road pavement. In the present study, an attempt has been made to use reclaimed polyethylene which has been obtained from plastic packets used in dry form with the aggregates like a fiber in a bituminous mix. Detailed study on the effects of these locally waste polyethylene on engineering properties of bituminous mixes, has been made in this study.

KEYWORDS: Waste Plastic, Aggregate, Bitumen.

I. INTRODUCTION

Plastic is a non-biodegradable material. Despite, the quantum of plastic waste is also increasing day by day which is hazardous to our health. Thus using plastic waste for construction purpose on flexible pavements will be one of the alternatives for disposing them in an eco-friendly manner. The plastic waste in a road pavement in Bangalore city. Today, every vital sector of the economy starting from agriculture to packaging, automobile, building construction, been virtually revolutionized by the applications of communication or InfoTech has plastics. Plastic in different form is found, which is toxic in nature. It is commonly collected both urban and rural areas. It creates stagnation of water and associated hygiene problems. Plastic waste is hazardous to the environment. Plastic waste can be reused productively in the construction of road. Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two major benefits (i) it will help clear valuable land of huge dumps of wastes. (ii) use of waste plastics on the road has helped to provide the better place for burying the plastic waste without causing disposal problem, thus protecting the environment.

Research Problem

To utilize the waste plastic and reduce the problem created in the environment by this Non-biodegradable Material & To reduce the cost of construction of road pavement & increase the strength of the road.

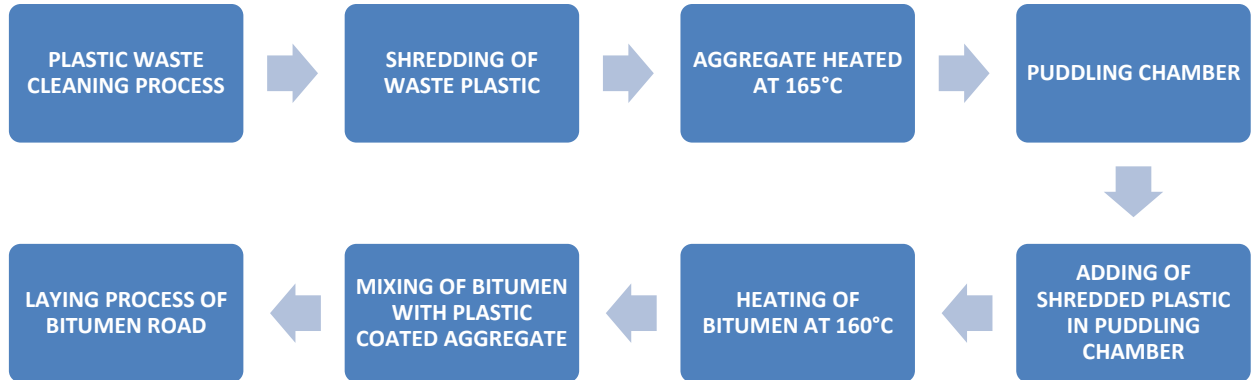
II. OBJECTIVES

- 1.1. To study effect of addition of plastic in bitumen mix on various test for strength of bitumen mix.
- 1.2. To study effect of coating of plastic on aggregates on various test of aggregates.
- 1.3. To compare the strength of bitumen and aggregates with conventional methods..



III. METHODOLOGY

3.1 Flow Chart For Plastic Tar Road Laying Dry Process (Wearing Coarse)



3.2 Mixing Procedure At Hot Mix Plant

- 3.2.1 Plastics waste like bags, bottles made out of PE and PP cut into a size between 2.36 mm and 4.75mm using shredding machine. Care should be taken that PVC waste should be eliminated before it proceeds into next process.
- 3.2.2 The aggregate mix is heated to 165°C and then it is transferred to mixing chamber. Similarly the bitumen is to be heated up to a maximum of 160°C. This is done so as to obtain a good binding and to prevent weak bonding. During this process monitoring the temperature is very important.
- 3.2.3 At the mixing chamber, the shredded plastics waste is added over the hot aggregate. It gets coated uniformly over the aggregate within 30 to 45 seconds. It gives an oily coated look to the aggregate.
- 3.2.4 The plastics waste coated aggregate is mixed with hot bitumen. Then this final resulted mix is used for laying roads. The road laying temperature is between 110°C 120°C. The roller used should be of is 8-ton capacity.

3.3 Laying Process Of Bitumen Road

- 3.3.1 Preparation of existing surface
- 3.3.2 Spreading the plastic coated aggregate
- 3.3.3 Rolling
- 3.3.4 Bitumen application
- 3.3.5 Spreading of key aggregate
- 3.3.6 Seal coat
- 3.3.7 Finishing
- 3.3.8 Opening to traffic

IV. EXPERIMENTAL PROGRAM

1.4. Preparation Of Design Mix

Pavement Coarse	Sample Constitution	Sample Preparation	% Constituent by Weight of Bitumen
Wearing Coarse	Bitumen + (Plastic + Stone Aggregate at 165 ⁰ c)	Dry Process	Plastic:8%
			Plastic:10%
			Plastic:12%

1.5. Experimental Work

Following Tests were conducted to investigate the properties of the aggregate as well as bitumen.

Sr No	Particular	Test Results	Specific limit
Aggregate			
1	Aggregate Impact Value	11.91%	Max 27%



2	Combine Flakiness and Enlongation Index	20mm	18.47%		Max 35%	
		10mm	21.29%			
3	Specific Gravity and Water Absorption		Sp.Gr	Water Abs.	Sp.Gr	Water Abs.
	20mm		2.890	0.912	*	<2
	10mm		2.830	1.026	*	<2
	6mm		2.821	1.078	*	
	Stone dust		2.700		*	
	Cement filler		2.755		*	
4	Striping Value of Aggregate		97.50%		Min 95%	
5	Cleanliness Test		2.00%		Max.5%passing 0.075mm sieve	
Bitumen VG 30 Grade						
1	Specific Gravity		1.028		0.99-1.02	
2	Ductility at 250° cm min		91		Min 75cm	
3	Softening Point		50		Min 470°	
4	Penetration at 250° 100gm 5sec 1/10mm		66		Min 45	
5	Absolut Viscosity Test 600° poises		2797		2400-3600	

V. SITE DETAILS

Experimental construction of 300 m long & 3.2 m wide bitumen road strip using plastic with bitumen

Venue: GollibarMaidan Pune Cantonment Board.

Guidance: M. B. Sable Sir (Sectional Engineer) and Patil Sir

VI. EXPERIMENTAL RESULTS

1. Stability:

It is observed from graphs that with increase in bitumen concentration the Marshall stability value increases up to certain bitumen content and there after it decreases. That particular bitumen content is called as optimum binder content (OBC). OBC are found as 5.5% for modified BC mixes with polyethylene at different concentration. From the graphs it can be observed that with addition of polyethylene stability value also increases up to certain limits and further addition decreases the stability. This maybe due to excess amount of polyethylene which is not able to mix in asphalt properly. That polyethylene concentration in mix is called optimum polyethylene content (OPC) which is found as 8% for BC mixes.

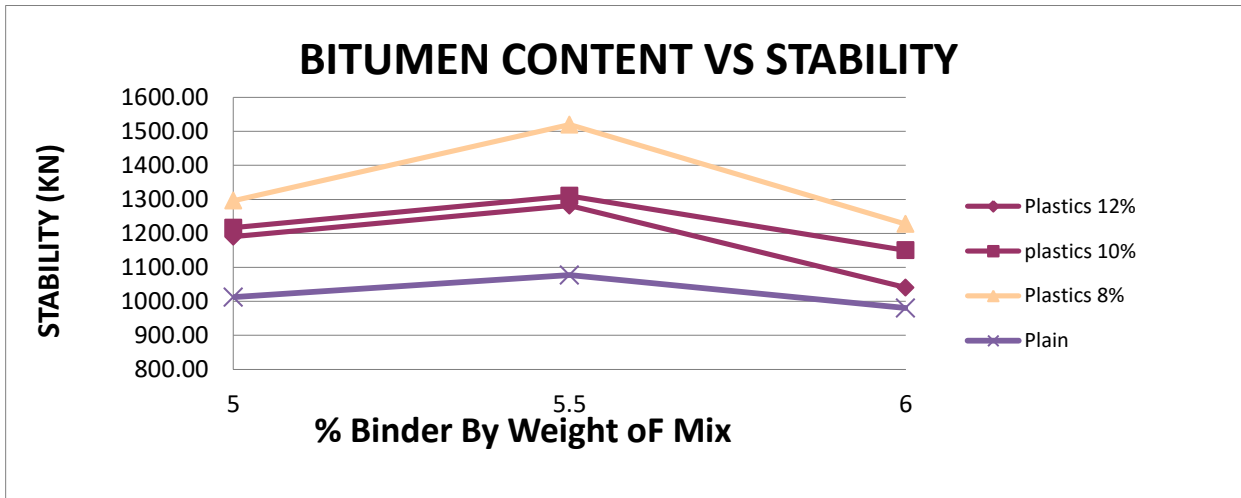


Fig. 6.1 Variations of Marshall Stabilities of BC with different binder and polyethylene Contents.

2. Flow Value:

It is observed from graphs that with increase in binder content flow value increases but by addition of polyethylene flow value decreases than that of conventional mixes, again further addition of polyethylene after OPC the flow value starts to increase.

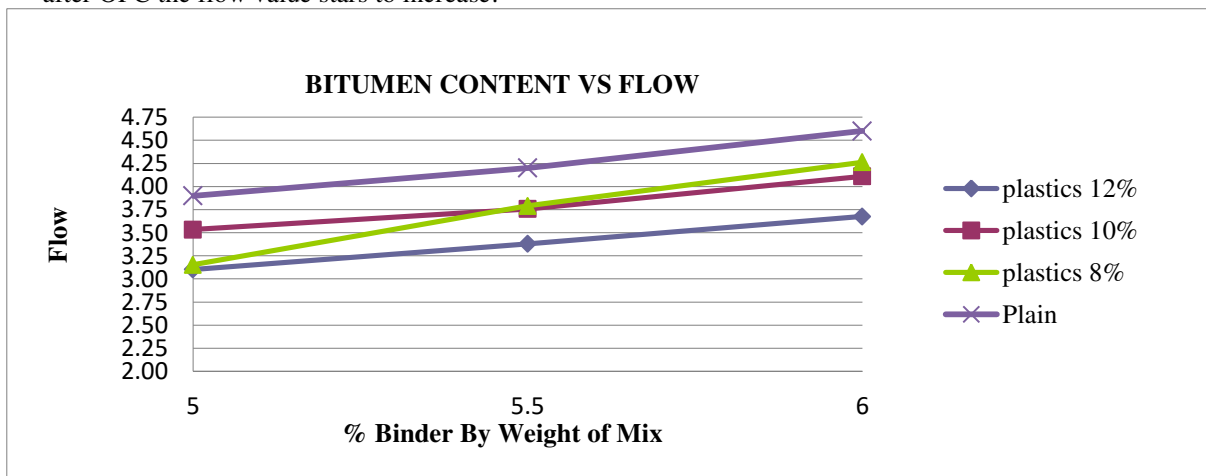


Fig.6.2 Variations of flow values of BC with different binder and polyethylene contents

3. Air void (VA)

It is observed that with increase in binder content air void decreases. But with addition of polyethylene to mix the air void is increasing than that of conventional mixes.

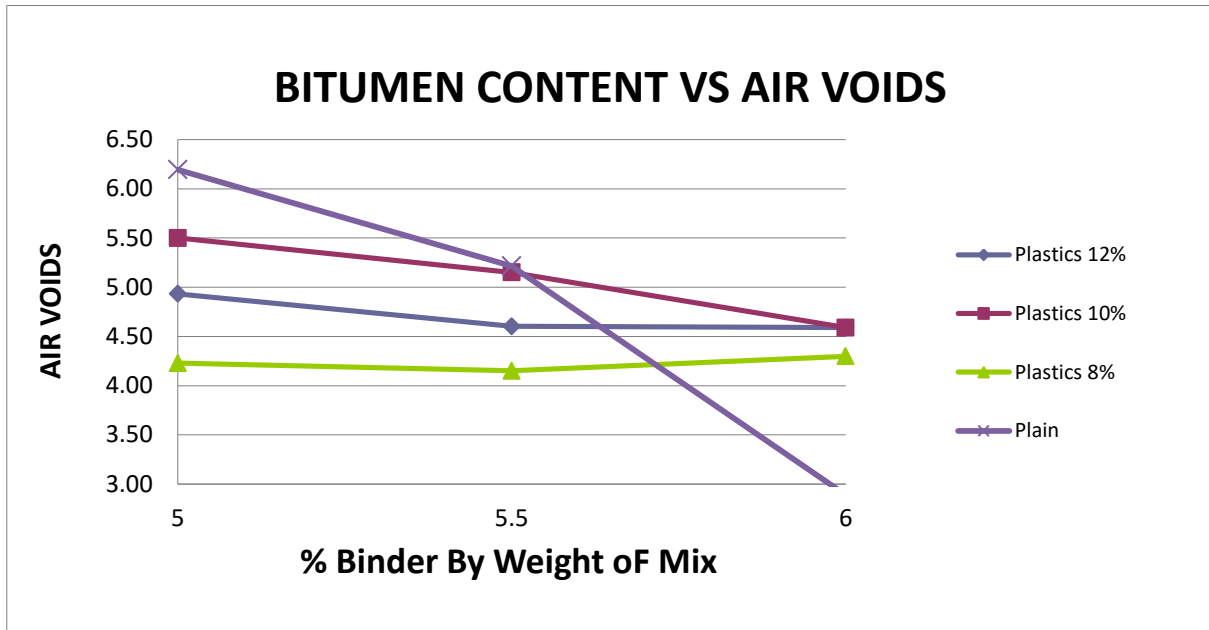


Fig. 6.3 Variations of VA values of BC with different binder and polyethylene Contents

4. Unit weight :-

It is observed that unit weight is increasing with increase binder concentration up to certain binder content

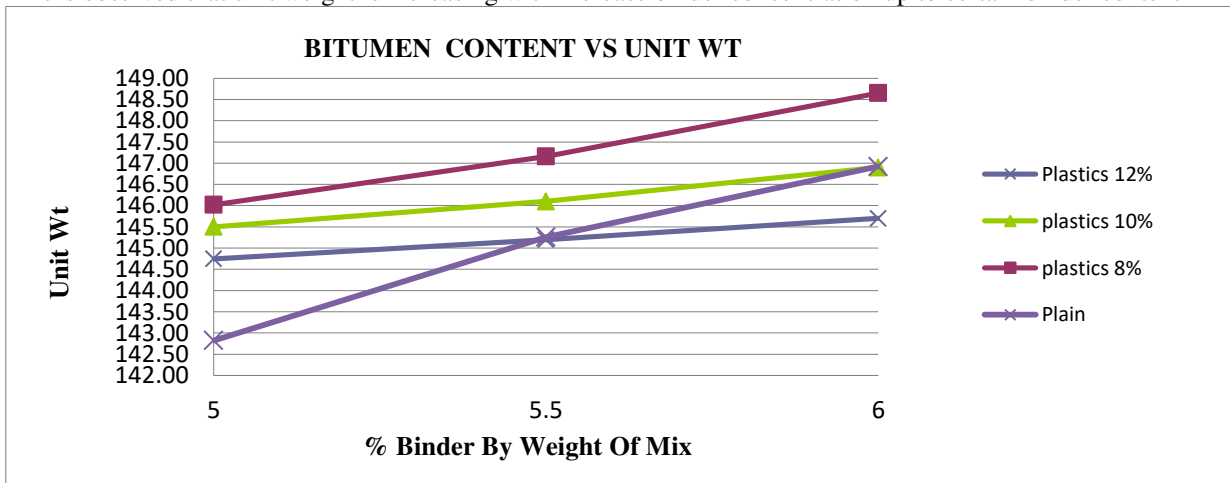


Fig. 6.4 Variations of unit weight values of BC with different binder and polyethylene contents

5. Void in mineral aggregate (VMA)

It is observed that first VMA decreases and then it increases at sharp rate with increase in bitumen concentration in mixes. Variation of VMA values with different binder contents and with different polyethylene contents are shown in graphs below. From the graphs it is observed that with addition of polyethylene to mix the VMA values increases than that of conventional mixes.

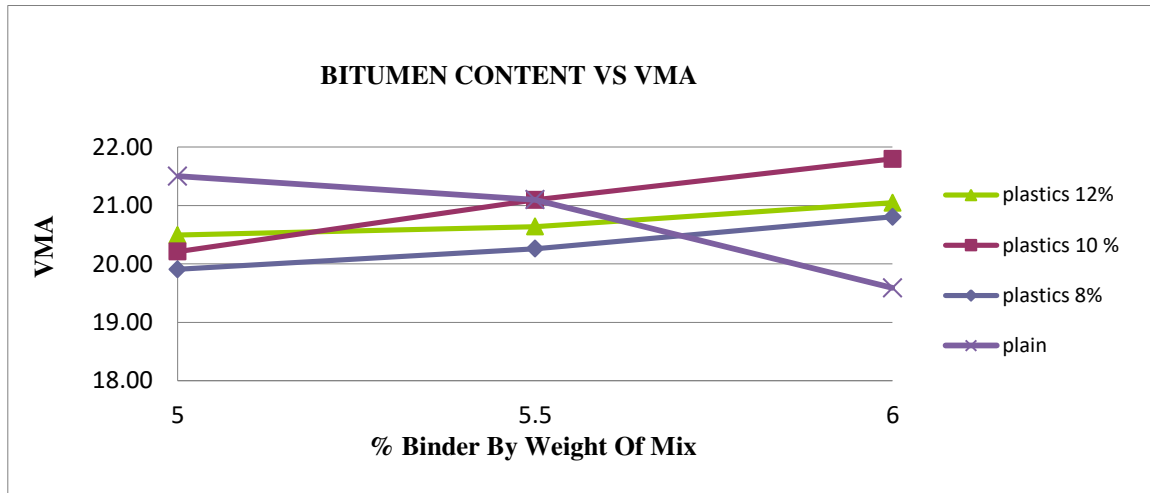


Fig. 6.5 Variations of VMA values of BC with different binder and polyethylene Content

6. Void filled with bitumen (VFB):

It is observed that VFB values of different mixes increase at sharp rate with increase in bitumen concentration. Variation of VFB with different binder content with different polyethylene content is shown in graphs below. From these graphs it is observed that with addition of polyethylene to mix the VFB increases than that of conventional mixes.

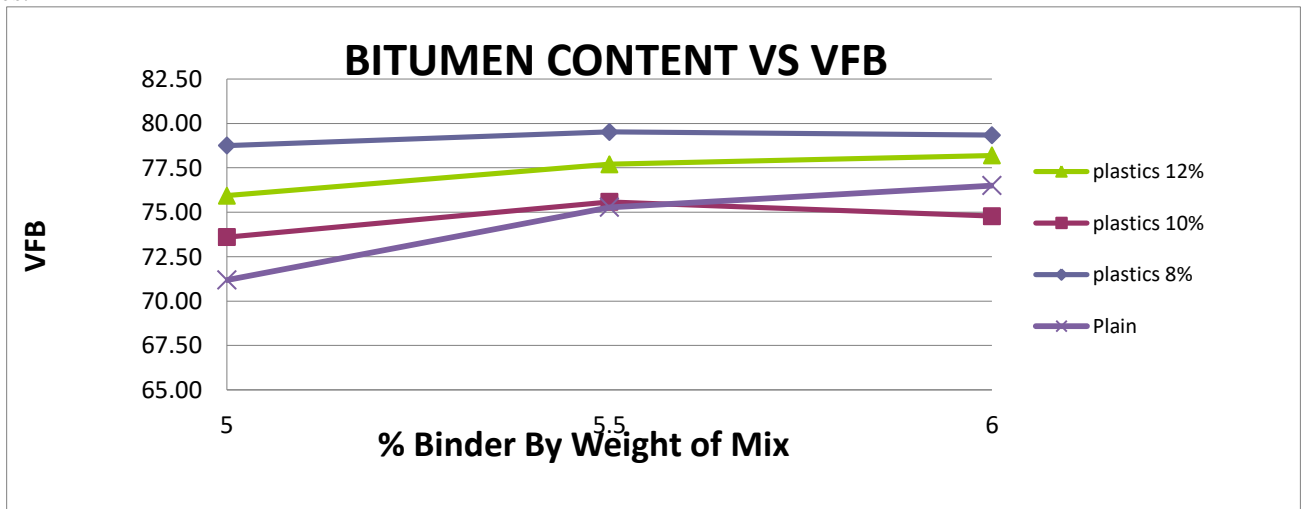


Fig. 6.6 Variations of VFB values of BC with different binder and polyethylene content

V. CONCLUSION

- 1.6. This study not only constructively utilizes the waste plastic and tyres in road construction industry but it has also effectively enhanced the important parameters which will ultimately have better and long living roads.
- 1.7. 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 heavy distresses. This adversely affects the life of the pavements. The polymer modified bitumen show better properties for road construction and plastics waste which otherwise are considered to be a pollution menace. It can find its use in this process and this can help in solving the problem of pollution because most of the plastic waste is polymers.
- 1.8. By conducting Marshall Stability the following conclusions can be drawn.
 - 1.8.1. By increasing the percentage of plastic, the stability values are decreased and required quantities of binder contents are decreased.
 - 1.8.2. Based on the stability values, the optimum percentage of plastic is 8% for 5.5% bitumen samples.
 - 1.8.3. Based on stability values the plastic coated aggregate samples are more stable can be used in road construction.



- 1.9. Our studies on the performance of plastic tar road conclusively proves that it is good for heavy traffic due to better binding , increased strength , reduce water penetration and better surface condition for a prolonged period of exposure to variation in climatic changes above all, the process helps to dispose waste plastics usefully and easily.
- 1.10. In short we can conclude that, using plastic waste in mix will help reduction in need of bitumen by around 8%, increase the strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly.
- 1.11. Increased traffic conditions are reducing the life span of roads. Plastic roads are means of prevention and ultimately will be the cure. It will save millions of dollars in future and reduce the amount of resources used for construction of roads.

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