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Experimental Study on Characterization of Bitumen Mixed with Plastic Waste

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ABSTRACT:

The disposal of waste plastic is a major problem. It is non-biodegradable and mainly consists of low-density polyethylene. The burning of these waste plastic bags causes environmental pollution. To find its utility in bituminous mixes for road construction and to contain this problem, experiments have been carried out on whether this waste plastic can be reused productively in the construction of roads. The experimentation at several institutes indicated that the waste plastic, when added to hot aggregate, will form a fine coat of plastic over the aggregate, and that such aggregate, when mixed with the binder, is found to give higher strength, higher resistance to water, and better durability over a period. Therefore, it is proposed that we may use waste plastic in the construction of rural roads. In this study, the shredded plastic waste is mixed in hot aggregate and the plastic modified mix is prepared using 5.5%, 7.5%, 9.5%, and 11.5%, plastic by weight of bitumen. It has been found that the Marshall stability value is at its maximum when 9.5% plastic waste is added to the mix. The other Marshall parameters are also improved with the addition of plastic waste into the bituminous mix.

Keywords: Plastic Waste, Bitumen, Marshall Stability

I. INTRODUCTION

Nowadays, we get snacks in plastic, food items packed in plastic, clothing and everything in plastic. The increasing dependency on plastic is a warning bell for us. Today, the availability of waste plastic is enormous, as plastic materials have become part and parcel of daily life. They either get mixed with municipal solid waste or thrown over land. If not recycled, their present disposal is either by land filling or by incineration. Both these processes have a certain impact on the environment. Under these circumstances, an alternate use for the waste plastic is also needed. In today's world, a complete ban on the use of waste plastic cannot be implemented. Sensible steps should be taken from the floor level to solve the threat of the disposal of plastic waste. It is possible to improve the performance of bituminous mixes used in the surfacing course of roads. The use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste, considered to be a pollution menace, can find its use. Plastic is a very resourceful material. Due to the industrial revolution and its large-scale production, plastic seemed to be a cheaper and more effective raw material. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4,500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. This paper investigates the effective use of waste plastic for coating the aggregates of the bituminous mix to improve its performance characteristics and to design an optimum bituminous mix. Recycled polythene carry bags were shredded into small pieces and mixed with aggregates of the bituminous mix at a specified temperature. Bituminous mixes were prepared with 60/70

bitumen and plastic-coated aggregates/ordinary aggregates with cement as a filler material. The Marshall Method is adopted for the mix design.

II. LITERATURE REVIEW

1. Dr. R. Vasudevan et. al (2007) found that the coating of plastics decreases the porosity, moisture absorption and improves soundness. The plastic- coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows greater Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods for easy disposal of waste plastics.

2. Yash Menaria et.al (2015) has presented a paper on the topic "Use of waste Plastic in flexible pavement-Green Road" He has concluded that "Utilisation of waste plastic improves the binding property of mix. The optimum result of waste plastic came out to be 8% from the experiments conducted. Plastic roads can also be constructed in the areas having high temperatures (50˚C). Waste plastic in roads increases the stability value and durability to a great extent.

3. Shaikh Azmat et al (2017) has presented a paper on the topic "Use of Plastic Waste in Road Construction" they state that by adding plastic to the modified bitumen, Marshall Stability and flow value have been improved. By using the plastic waste for road construction, we can reduce disposal of waste plastic which is harmful to the environment.

4. R. Manju Anand et al (2017) he has presented a paper on the topic "Use of Plastic Waste in Bituminous Pavement" The authors of this paper state that the polymer coated on aggregate reduce the void and moisture absorption. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road.

5. Amit P. Gawande (2013) "Economics and Viability Of Plastic Road" evaluated flexural fatigue life of asphalt concrete modified by 3% crumb rubber as part of aggregated and reported that fatigue life and creep properties of the polymer modified mixes increased significantly as compared to unmodified asphalt mixes.

III. OBJECTIVES

1. To utilize non-degradable plastic in bitumen.
2. To investigate and compare marshal stability with and without plastic waste.
3. To compare the various properties of the bituminous road and plastic bituminous road.
4. To identify the optimum proportion of waste plastic to be added to the bitumen mix to get the desired strength.

IV. METHODOLOGY

For the preparation of samples, materials are collected from different sources. There are two types of plastic, LDPE and HDPE. The waste plastics are collected from dump yards, houses, and tea stalls and they are segregated according to micron sizes. The plastic is cut into 2-4 mm pieces. The aggregate of 1200 g is taken of different sizes. An experimental test is performed for the following parameters:

1. Sieve Analysis
2. Plastic content Vs stability
3. Plastic content Vs flow value
4. Plastic Content Vs Voids filled with Bitumen(VFB)

5. Plastic content Vs Voids in Mineral Aggregate(VMA)
6. Plastic content Vs Voids in Mix (VM)

Table 4.1 Observation Table

Is sieve (mm)	Cumulative (%) passing	Cumulative (%) passing	Cumulative retained	Weight of aggregate taken
45	-	-	-	--
37.5	-	-	-	--
26.5	100	100	0	0
19	79-100	84.5	21.2	254.4
13.2	59-79	69	20.2	242.4
9.5	52-72	62	7.2	86.4
4.75	35-55	45	17.2	206.4
2.36	28-44	36	7.2	86.4
1.18	20-34	27	8.2	98.4
0.6	15-27	21	5.2	62.4
0.3	10-20	15	5.2	62.4
0.15	5-13	9	5.2	62.4
0.075	2-8	5	3.2	38.4

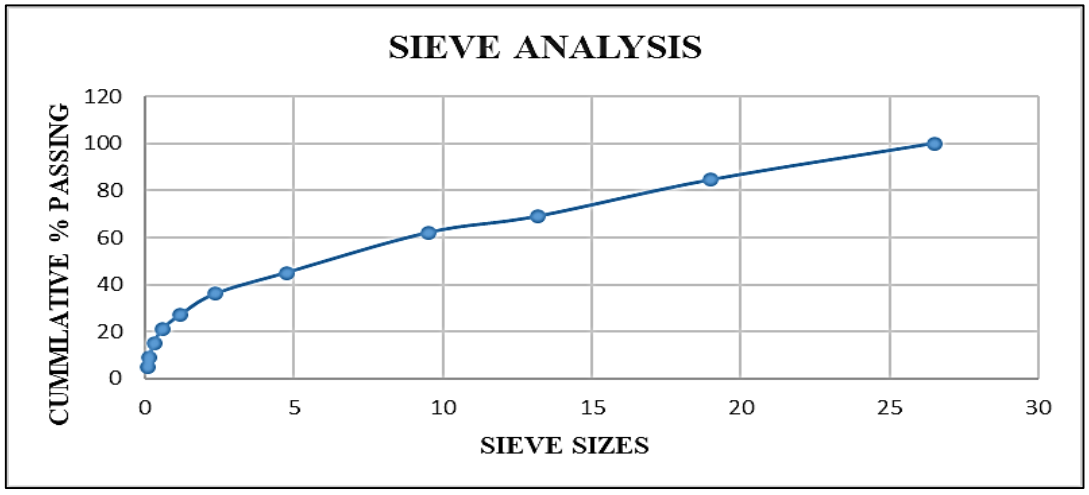

Fig 4.1 Sieve Analysis

For the sample preparation, a 25-gram sample of cement is taken as filler material. 5.5% of grade 60/70 bitumen is used.

The aggregates and filler are mixed in the required proportion as per the design requirements are fulfilling the specified gradation. Then the compaction mould prepared and oiled properly. The aggregate and filler are mixed and heated at temperature around 140-160^{0}C. At temperature less than 160^{0}c bitumen is added with plastic and plastic is taken at 5.5%,7.5%,9.5%, and11.5%. The prepared aggregate is then filled in compaction mould and hammered 75 times on bothsides at temperature of 80-100^{0}C.Then the sample is taken out from the

mould and kept at room temp for 24 hours. different series of specimens preparedby varying different plastic content. Dry weight of specimen is taken. then the mould is submerged in water and weight is taken. mould is taken out from water and weight is taken. specimen is kept in hot water bath for 30 min at temperature of 60^0c. Afterthat marshal stability test is carried out to findstability and flow value of specimen.

V. RESULTS

The following result was obtained from the test:

Table 5.1 Result Summary

MOULD NO	BITUEN CONTENT	PLASTIC CONTENT(%)	STABILITY (N)	FLOW VALUE (MM)	VA %	VMA %	VFB %	VM %
1	5.5%	0	22.22	4.0	92.41	7.59	70.89	2.2
2		5.5	27.35	4.5	90.36	9.63	59.22	4.03
3		7.5	28.93	4.6	89.52	9.81	58.46	4.2
4		9.5	26.65	4.8	89.56	10.43	55.94	4.7
5		11.5	24.04	5.4	90.44	9.55	62.18	3.6

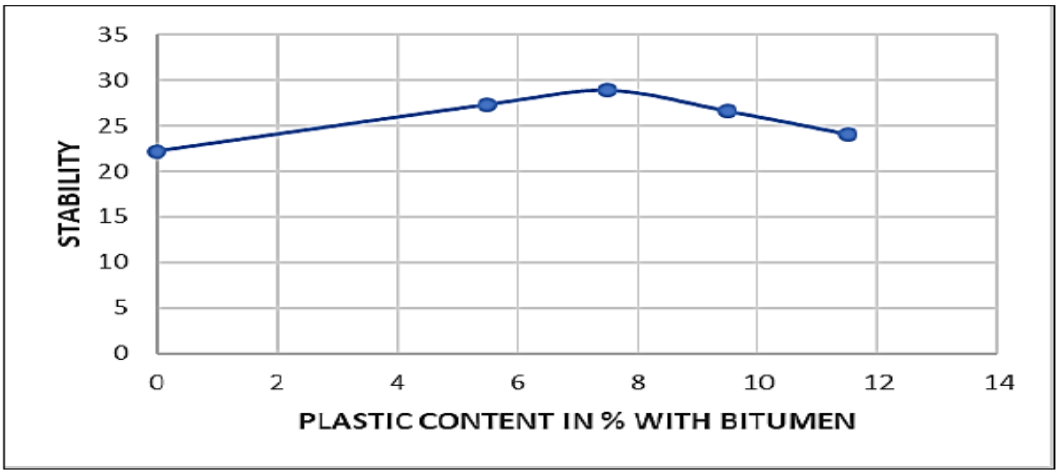

Fig. 5.1 Plastic Content Vs Stability

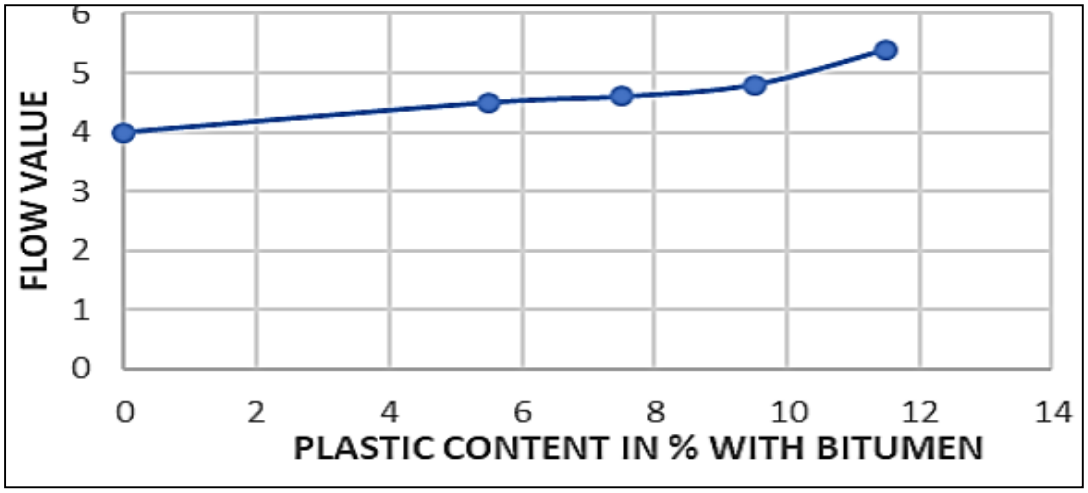

Fig. 5.2 Plastic Content Vs Flow Value

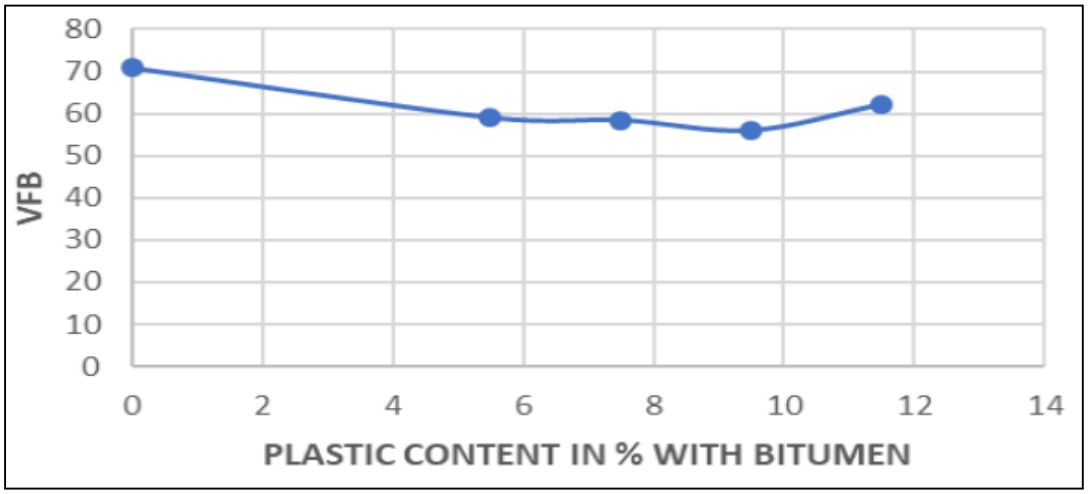

Fig. 5.3 Plastic Content Vs VFB

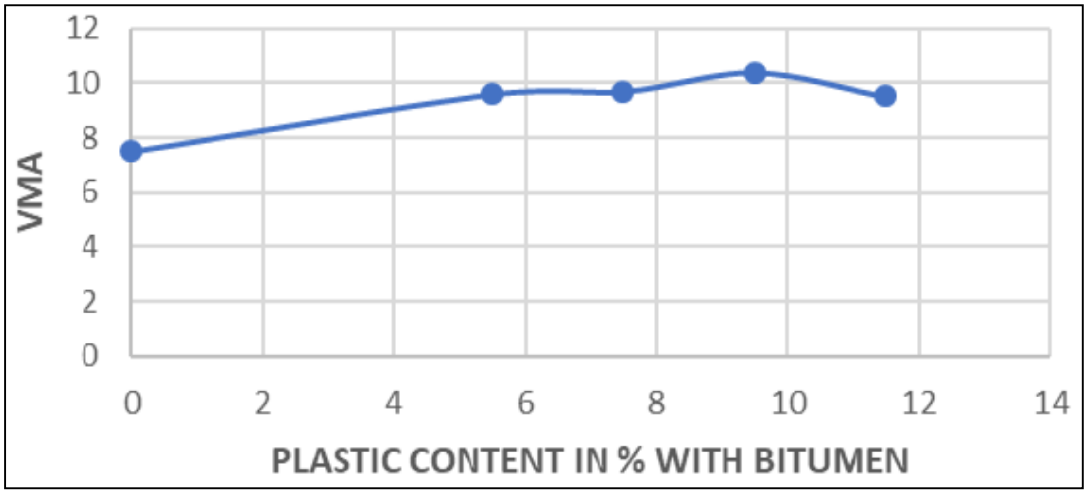

Fig. 5.4 Plastic Content Vs VMA

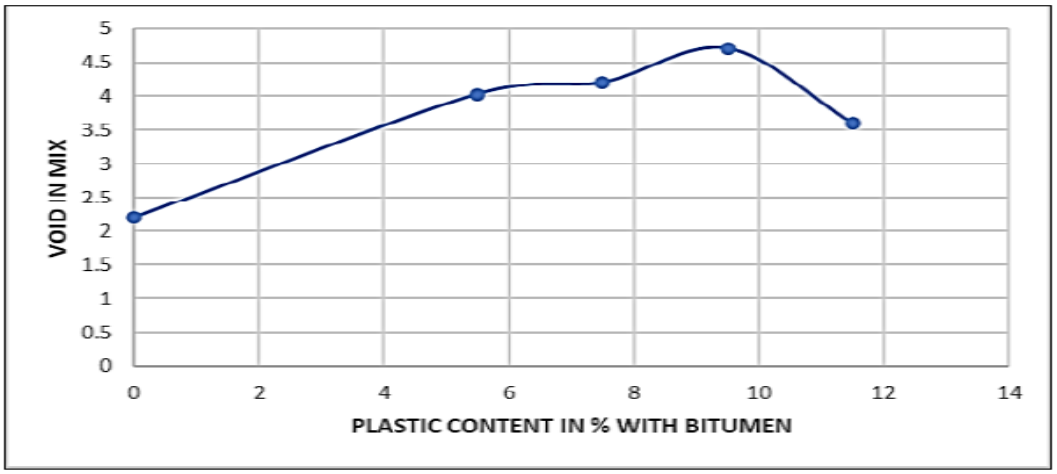

Fig. 5.5 Plastic Content Vs Void in Mix

VI. CONCLUSIONS

From the study of the behavior of plastic waste modified bitumen content, we conclude that the obtained results from the Marshall stability test of samples containing different proportions of waste plastics are reliable and hence the following conclusions are made.

1. The modified mix improved Marshall Characteristics.
2. In this analysis, when increasing the percentage of waste plastic in the mix, the Marshall stability value also increased.
3. The maximum stability is found for the mix containing 7.5% plastic by the weight of bitumen.
4. We further increased the plastic percentage. The Marshall Stability value goes on decreasing.
5. The flow value goes up with the addition of plastic content in the mix.
6. This study will have a positive impact on the environment.

VII. REFERENCES

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