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EFFECTIVENESS OF WASTE PLASTIC IN CONSTRUCTION OF BITUMINOUS ROAD

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Abstract — *In the present world bottles, packing strips etc. is increasing step by step. Thus, measure of waste plastic likewise increments therefore environmental issues rises. A considerable lot of the wastes created today will stay in the environment for many years leading to various environmental concerns. Therefore, it is important to use the wastes adequately with technical development in each field. In present review plastic waste, consisting of other utilized plastic is used as a coating over aggregate and this coated stone can be used for road development. Further The mix polymer coated aggregate has shown higher strength. Utilization of this mix for road construction helps to utilize plastics waste. Once the plastic waste is isolated from municipal solid waste, the natural matter can be changed over to fertilizer and utilized.*

Keywords- *Plastic Waste, Bitumen, Aggregates, Plastic Roads.*

I. INTRODUCTION

There are mainly two types 1. rigid pavement roads and 2. flexible pavement roads. Concrete used in rigid roads and bitumen for flexible roads. In India, for the most part flexible pavement roads are accessible. Road characteristics improved by the significant variation in every day and temperature variation demand. Improvement in the property of the binder is required.

Today the accessibility of the waste plastics is tremendous, as the plastic materials have moved toward becoming an integral part of daily life. If not reused, their present disposal is either by land filling or by incineration. Both the procedures have certain effect on the environment. Under this condition, a substitute use for the waste plastics is additionally the required.

Plastics melt to form an oily coat over the aggregate when mixed with hot bitumen and the mixture is laid on the road surface like a ordinary tar road. In the development of flexible pavements, bitumen assumes the part of binding the aggregate together by covering over the aggregate. It also helps to enhance the quality of the road. Be that as it may, its resistance towards water is not good. Anti-stripping agents are being utilized. A typical technique to enhance the strengh of bitumen is by altering the rheological properties of bitumen by blending with natural synthetic polymers like rubber and plastics. Thinks about this matter are going on both at national and worldwide level.

II. STUDY OF WASTE PLASTIC

Waste plastics - as binder and modifier:

130°C Thermo-gravimetric examination has demonstrated that there is no gas evolution in the temperature range of 130-180°C. Also, the softened plastics have a binding property. Henceforth, the liquid plastics materials can be utilized as a binder as well as they can be mixed with binder like bitumen to enhance their binding property. This might be a decent modifier for the bitumen, utilized for road construction.

Need:

1) Waste Disposal of plastic is a prime problem
2) Waste plastic is non-perishable
3) Scorching of plastic bags further leads to environmental pollution.
4) Low-density polyethylene is the main product of waste plastic.

III. MATERIALS & METHODS

Waste materials of Waste Plastic Bottles were collected from local area and shredded 2.36 mm to 4.5 mm particle size. Plastic waste with different proportions material mixed with bitumen grade and experiments were carried out to determine (i) bulk density, (ii) stability, (iii) flow quality and (iv) void analysis.

Experimental Mould Assembly

The mould assembly consisted of cylindrical moulds of diameter 101.6 mm and height 60 mm with a base plate and collar extension and a sample extractor for extruding the compact specimen from the mould.

Figure. 1 Mould assembly and testing

IV. MARSHALL TESTING FOR BITUMINOUS MIXTURE STABILIZATION BY ADDING WASTE PLASTIC MATERIALS

Procedure:

Heat the weighed aggregates and the bitumen separately up to 170^{o}C and 163^{o}C respectively. Mix them and transfer the material to the compaction mould. Give 75 blows on the top side of the specimen mix with a standard hammer. Reverse the specimen and again give 75 blows. Take the mould and cool it for a few minutes. Remove the specimen from the mould and cure it at room temperature, overnight. A series of specimens are prepared with varying quantities of bitumen content, with an increment of 0.5%. Check the stability on the Marshall Stability apparatus.

Table 1. Material Proportion

Materials	Percentage %(1200 gm)
Coarse Aggregate (20mm size)	45 % (540 gm)
Fine Aggregate (6mm size)	26% (312 gm)
Stone dust	26% (312 gm)
Lime	3% (36 gm)

Aggregate used in the study has been tested as per the procedure given in relevant IS codes. All these tests should satisfy the requirement given in section 500 clauses 509 Table 500-17 MORTH. Test results of aggregate shown in Table 2.

Table 2. Aggregate Properties

Sr. No.	Test on Aggregate	Obtained results	MoRTH Requirements (IV revision) Specifications
1	Impact value (%)	19.22%	Max 24%
2	Abrasion value Los Angeles (%)	27.5%	Max 30%
3	Combined index (%)	28%	Max 30%
4	Water absorption (%)	0.43%	Max 2%
5	Coarse aggregates Specific gravity	2.72	2.5-3.0
6	Fine aggregates Specific gravity	2.76	2.5-3.0

From above Table 2 it should clearly see that aggregate used in the study satisfied the entire requirement which indicate that the aggregate having all the required physical properties. Therefore, study has been continued further along with this aggregate.

Properties of Bitumen used in Present Study is given in Table 3.

Table 3. Bitumen Properties

Sr.no.	Properties	Grade 60/70	REFERENCES
1	Penetration at 25ºC	67	IS:1203-1978
2	Softening point (R&B) ºC	51	IS:1205-1978
3	Ductility @27ºC, cm	73.5	IS:1208-1979
4	Specific gravity of bitumen	1.017	IS:1202-1980

Sieve analysis has been carried out for the aggregate to be tested for their physical properties and Grading of aggregate is to be determining for Mix design which must satisfied the MORTH requirement for nominal size of aggregate 19 mm.

The final blend of Gradation for aggregate used in the study shown below in Table 4.

Table 4. Gradation of Aggregate for Mix Design

GRADATION

Sieve Size(mm)	**19mm**	**6mm**	**Stone Dust**	**Lime**	**Blend**
	45%	26%	26%	3%	100%
19	100	100	100	100	100
13.2	41	100	100	100	73
9.5	1	97	100	100	55
4.75	0	45	91	100	38
2.36	0	4	90	100	28
1.18	0	0	66	100	20
0.600	0	0	59	100	18
0.300	0	0	32	99	12
0.150	0	0	20	91	8
0.075	0	0	2	65	3

V. MARSHALL MIX DESIGN RESULTS

Optimum Binder Content:

Optimum binder content of BC determines by performing Marshall Test on sample prepared at varying binder content shown in Table 5.

The volumetric properties of BC mix using VG 30 shown in Table 2 and it seen that design mix satisfied the all volumetric requirement of BC as per MoRTH section 500 clause 509.

VI. RESULTS AND DISCUSSION

The experimental results are discussed with reference to the following tests:

- bulk density,
- stability,
- flow and
- void tests.

There were 5 sample molds in total and each one was subjected to three different kinds of tests at least, leading to a minimum of 20 tests. Results are shown here.

Table 5. Results of Stability and Flow Value at Different Bitumen Content

OBC	Vv	VMA	VFB	Vb	STABILITY (Kg)	Avg. Stabilty (kg)	FLOW VALUE	Avg. Flow value
4.50	4.93	14.97	67.23	2.234	860	846	2.3	2.66
					790		2.9	
					888		2.8	
4.75	4.44	15.05	70.12	2.236	877	927.33	2.9	3.067
					965		3.3	
					940		3.0	
5%	3.66	14.32	74.48	10.67	1201	1140	3.8	4.3
					1129		4.4	
					1090		4.7	
5.5%	3.29	15.07	78.19	11.78	1212	1247.33	5.8	5.267
					1276		5.1	
					1254		4.9	
6%	2.56	15.34	83.30	12.78	1178	1216.33	4.6	4.867
					1264		4.9	
					1207		5.1	

Table 6. Stability and Flow Value at Different Waste Plastic Content

Waste Plastic %	Vv	VMA	VFB	Vb	STABILITY	FLOW VALUE
6%	3.91	15.64	68.59	10.73	1433 Kg	5.4
8%	4.5	14.10	84.49	11.92	1525 Kg	6
10%	5.6	14.43	89.90	12.97	1481 Kg	5.2
12%	5.9	16.8	64.8	13.76	1059 Kg	4.4
14%	7.2	18	59.8	14.42	966 Kg	3.5

From the stability data of all the five binders, we noted that the binders with 8% and 10% had a better stability as compared to others. Binder with 10% contained more plastic than 8%. But the most suitable stability-tested binder was with 8% of polyethylene. The effect on the flow was maximum but well within the range. Since the binder with 8% was noted to be the best from the Marshall stability and flow data, further studies on void analysis were reported for that binding sample.

Marshal stability of 1525 kg was greater than the standard of a minimum 1247kg. The flow range of 3.5-6.0 was also well within the required range. The air voids (VA), VMA and VFA were all within the standard ranges (**Table 6**). The results were noted to be satisfactory.

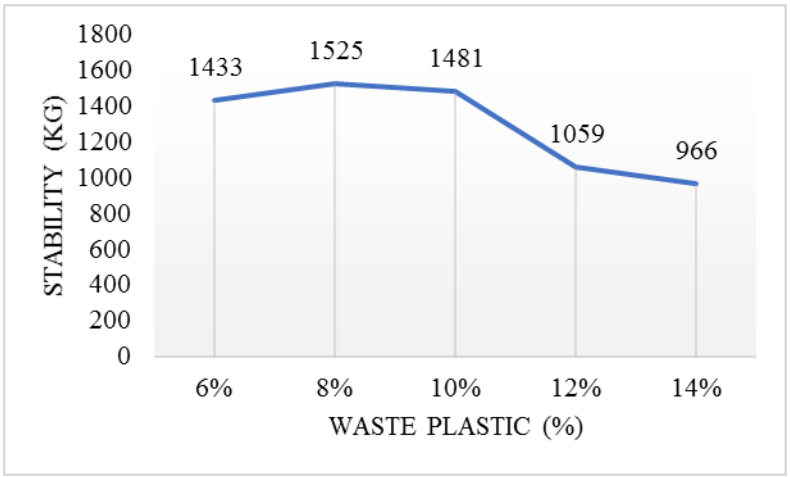

Figure 2. Relation Between Waste Plastic and Stability

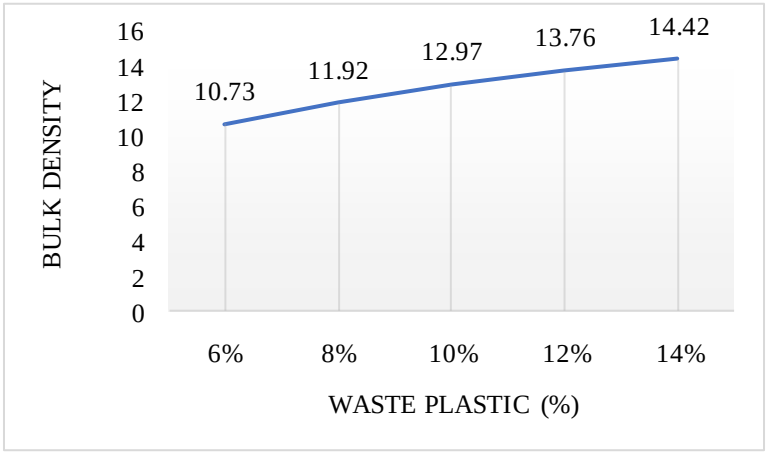

Figure 3. Relation Between Waste Plastic and Bulk Density

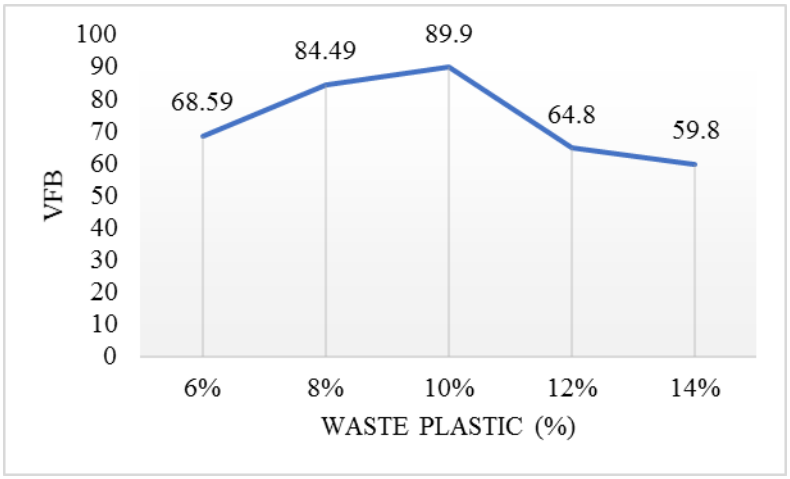

Figure 4. Relation Between Waste Plastic (%) and Void Filled Bitumen

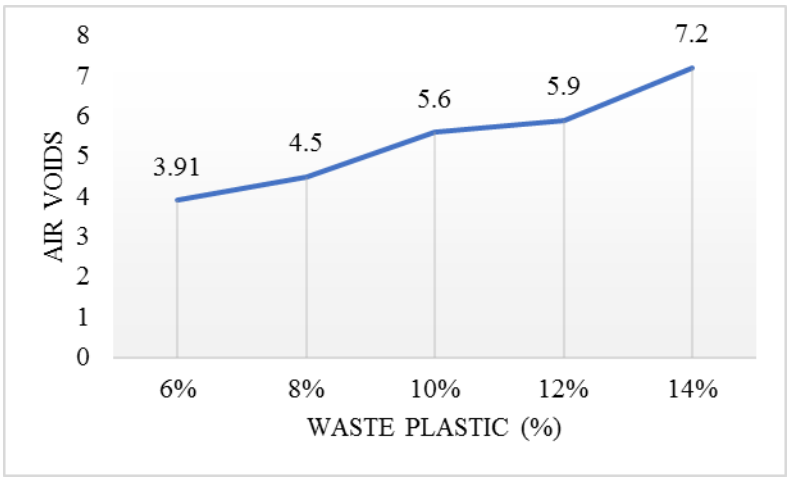

Figure 5. Relation Between Waste Plastic (%) and Air Voids

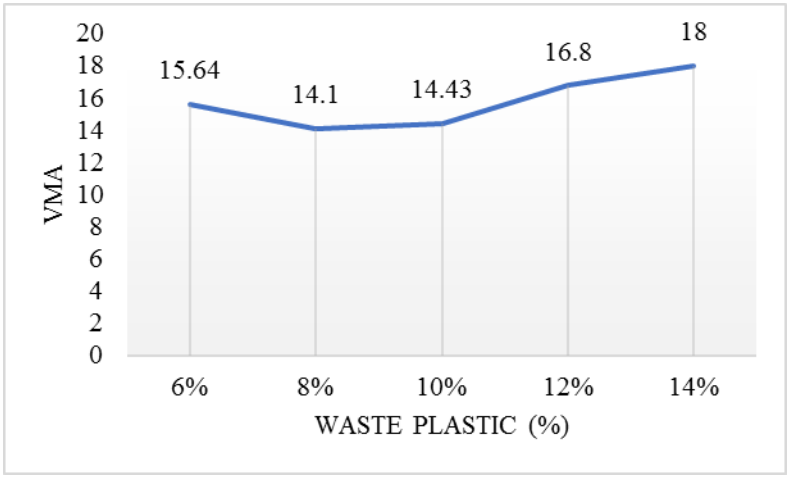

Figure 6. Relation Between Waste Plastic (%) and Void Mineral Aggregate

VII. CONCLUSION

Since bitumen grade of 60/70 guidelines match with the general specification of MoRTH, the same has been adapted in the present work for using in Marshall Stability Method using waste plastic. The studies conclusively showed that that the waste plastic materials could be incorporated as a binding agent for the construction of roads. From the study following conclusion are made:

- Maximum stability 1525 Kg was achieved with using 8% waste plastic by its total weight.
- Minimum void mineral aggregate 14.10% was obtained using 8% waste plastic by its total weight of material.
- Maximum flow value is observed as 6 for 8% waste plastic by its total weight of material.
- Low density polyethylene (LDPE) to an extent of 8% was found to be the most effective binder proportion.

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