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Improving the Performance of Bituminous Concrete Mix by Waste Plastic.

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Abstract
The population of our country is increasing rapidly and due to it plastic waste is also increasing day to day due to urbanization, development activities and changes in life style, which leading extensive environment pollution. Thus disposal of waste plastic is a threat and become a serious problem globally due to their non-biodegradability and anaesthetic view. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics of road mix. In the present paper developed techniques to use plastic waste for construction purpose of roads and flexible pavements has reviewed. In conventional road making process bitumen is used as binder. Such bitumen can be modified with plastic waste pieces and bitumen mix is made, which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mix show better binding property, stability, stiffness, density and extra resistant to water.
Keywords: Optimum Bitumen content, Mechanical characteristics, Bitumen mix.

I. INTRODUCTION

In the present life style a complete ban on the use of waste plastic cannot be put. The sensible steps should be taken from the floor level to solve the threats of 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. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low – temperature cracking of the pavement surfacing. Plastic is a very resourceful material. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 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 sizes and mix with aggregates of the bituminous mix at specified temperature. Bituminous mixes were prepared with 60/70 bitumen and plastic coated aggregates/ordinary aggregates with cement as a filler material. Marshall Method is adopted for the mix deign.

II. MATERIALS, METHODS AND PROPERTIES

The experiments were conducted in the laboratory on bituminous mixes 60/70 and plastic modified bituminous mixes samples. The Marshal Mix design method of bituminous mix was carried out and comparison was made in between bitumen mix properties with plastic modified bitumen. The different laboratory test was conducted to determine the Individual properties like Aggregate crushing value, Impact value, Specific Gravity, Los Angeles Abrasion, Flakiness Index, Elongation index, Water absorption, Soundness, Stripping value.

The materials used for the preparation of mix are

A. Aggregates.

Aggregate was obtained from a local quarry and the physical properties were tested in the laboratory and are given in Table 1. To get the required gradation, three grades (A, B, C) of aggregates were used. The grading curves are shown in Fig 1 to.3

TABLE 1
PROPERTIES OF AGGREGATES

Sl.No	Property	Test result	Remarks
1	Aggregate crushing value	30.9%	satisfactory
2	Impact value	29.9%	
3	Specific gravity	2.65	
4	Los Angeles Abrasion value	32.5%	
5	Flakiness Index	13.52%	
6	Elongation index	8.77%	
7	Water absorption	0.38%	
8	Soundness	9.97%	
9	Stripping value	0%	

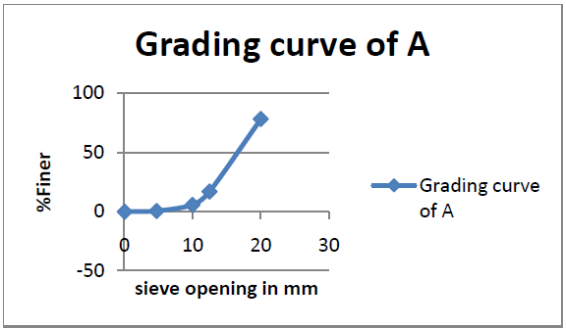


Fig. 1 Grading curve of aggregate A

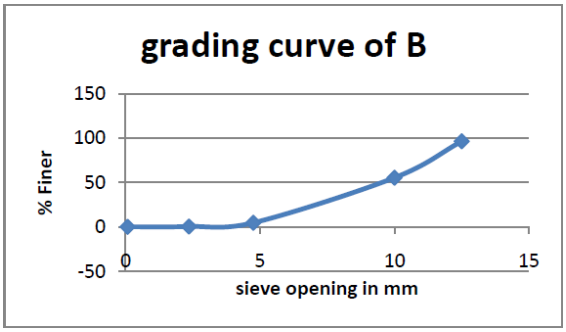


Fig. 2 Grading curve of aggregate B

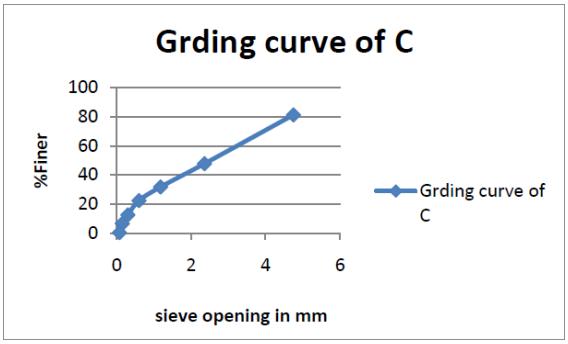


Fig. 3 Grading curve of aggregate C

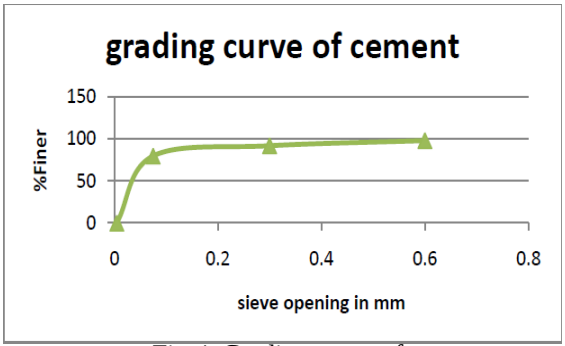


Fig 4. Grading curve of cement

B. Bitumen.

60/70 bitumen was obtained from Mathura refineries Ltd. The physical properties of this bitumen are shown in
Table 2.

C. Plastic.

The waste plastic used was polythene carry bags (less than 30microns) collected from the nearby locality. It was shredded in a shredding machine (particle size 2-3mm).

D. Filler.

Ordinary Portland cement was used as the filler material. The gradation of cement is shown in Fig 4.

TABLE.2
PROPERTIES OF BITUMEN

Sl.No	Property	Test result	Remarks
1	Softening point of bitumen	409C	satisfactoy
2	Ductility Value	81.9cm	
3	Specific gravity of bitumen	1.0	
4	Penetration Value	65	
5	Viscosity of bitumen	72sec	

E. Plastic coated aggregates.

The aggregate was heated to a temperature 140-1500C.The shredded plastic was added to the hot aggregate with constant mixing to have a uniform

distribution. The plastic softened and coated over aggregate. Its properties were tested and are given in Table 3.

TABLE 3: PROPERTIES OF PLASTIC COATED AGGREGATE

Sl.No	Property	Test result	Remarks
1	Aggregate crushing value	29.8%	satisfactory
2	Impact value	26.9%	
3	Specific gravity	2.72	
4	Los Angeles Abrasion value	31.2%	
5	Flakiness Index	12.5%	
6	Elongation index	9.85%	
7	Water absorption	0%	
8	Soundness	3%	
9	Stripping value	Nil	

F. Marshall method of mix design

The mix design should aim at an economical blend, with proper gradation of aggregates and adequate proportion of bitumen so as to fulfil the desired properties of mix.

1) Proportioning of aggregates.

It is done by Rutherfoth method and different proportions are shown below:

Aggregate A- 15%
Aggregate B- 32%
Aggregate C- 51%
Cement- 2% (filler)

The final gradation of the mix with the requirement of MOST (Ministry Of Surface Transport) is shown in
Table 4

TABLE 4: RESULTING GRADING

Sieve opening(mm)	%Finer	MOST specifications	Remarks
26.5	100	100	satisfactory
19	97	90-100	satisfactory
9.5	71	56-80	satisfactory
4.75	41	35-65	satisfactory
2.36	24	23-49	satisfactory
0.3	5	5-19	satisfactory
0.075	3	2-8	satisfactory

2) Preparation of Test Specimen

The standard specimens were prepared with ordinary aggregate and plastic coated aggregate at different percentages of bitumen as per specifications. Three specimens of each were prepared and tested.

3) Properties of Compacted specimens.

The various properties tested are specific gravity, percentage air voids (VV), percentage Voids in Mineral Aggregate (VMA), percentage Voids Filled with Bitumen (VFB) and bulk density. The variations of these properties with % bitumen are shown in Fig 5 to 9.The test results for different specimens are shown in Table 5.

TABLE 5
MARSHALL PROPERTIES

Bitumen By weight Of mix (%)	Bitumen by weight of Aggregate (%)	Specific gravity		Volume % total			Voids %		
		Bulk average	Theo.max.	Bitumen	Aggregate	Voids=	VMA	VFB	Vv
4	4.2	2.44	2.54	10.205	86.21	**3.575**	14.15	69.98	3.94
4-plastic	4.2	2.31	2.54	9.65	81.62	8.72	18.75	51.52	9.09
4.5	4.7	2. 45	2.509	11.24	84.32	3.96	15.93	70.49	2.7
4.5-plastic	4.7	2.4	2.509	11.24	84.34	3.96	15.93	56.3	4.9
5	5.3	2.36	2.487	12.49	82.5	4.93	17.83	72.09	5.35
5-plastic	5.3	2.23	2.487	11.76	77.85	10.36	22.54	64	10.77

1) Determination of Optimum bitumen content.

Marshall Stability test was conducted for different percentages of bitumen on ordinary aggregate mix and plastic coated aggregate mix .The results are shown in Table 6

III. TEST RESULTS AND ANALYSIS.

The physical properties of plastic coated aggregates are shown in Table 6. It is seen that the properties like water absorption, stripping value and soundness are improved using plastic coated aggregate. The optimum bitumen content is calculated based on the graphs plotted with bitumen content on X-axis and the values of the following parameters on Y-axis (Fig 5 to 9)

TABLE 6: MARSHALL TEST RESULTS

Bitumen by wt. Of mix	**Bitumen by wt. Of aggregate**	**Marshall stability value**	**Flow value (mm)**
4	4.2	1135.78	2.283
4-plastic	4.2	2299.488	3.7
4.5	4.7	1450.444	3.86
4.5-plastic	4.7	2737.008	5.10
5	5.3	906.315	5.15
5-plastic	5.3	2091.59	6.0

- % voids in total mix
- Unit weight
- %voids Filled with Bitumen (VFB)
- Marshall stability value
- Flow value

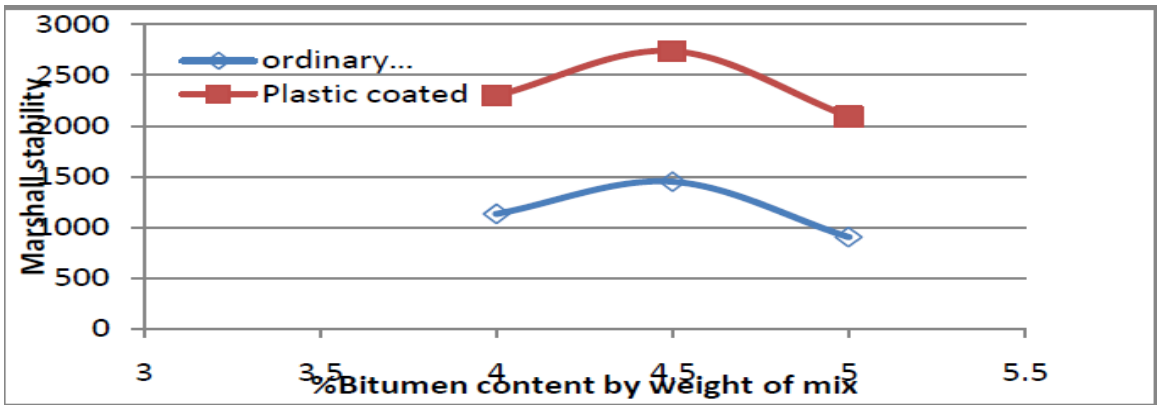


Fig. 5 Variation of Marshall Stability with % bitumen content

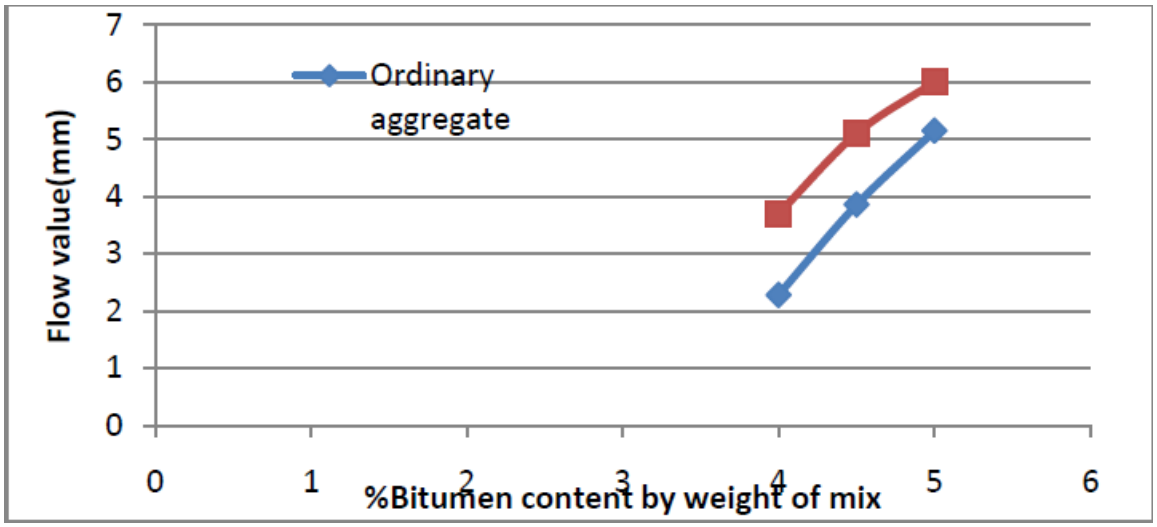


Fig. 6 Variation of flow value with % bitumen content by weight of mix

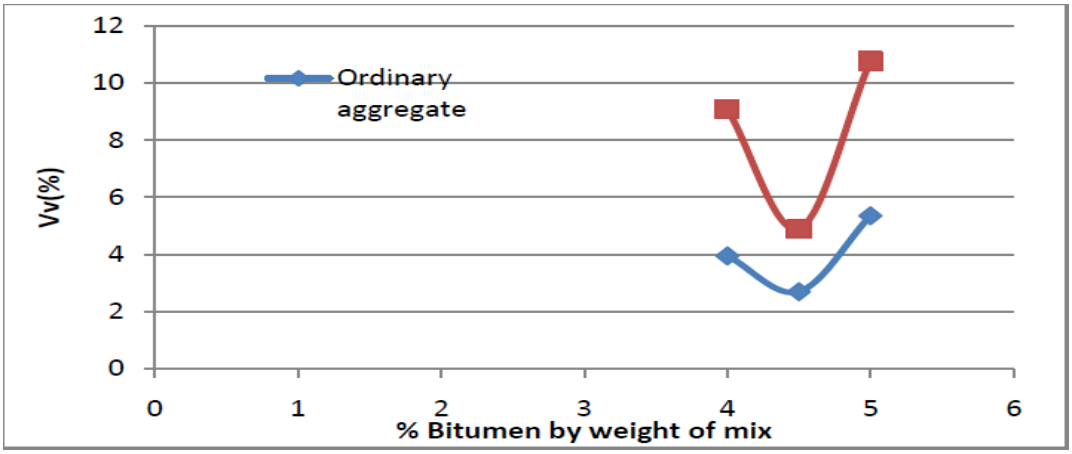


Fig.7 variation of %Vv with % bitumen content

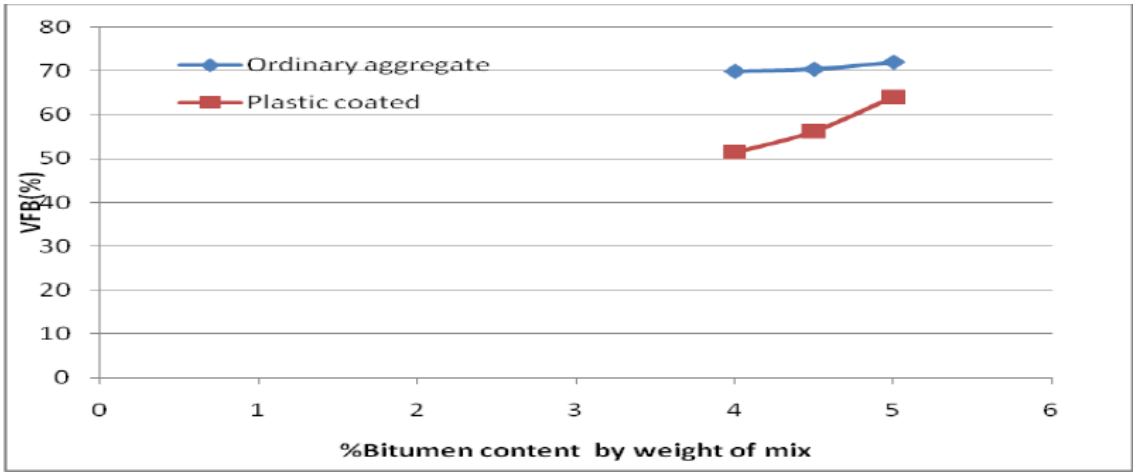
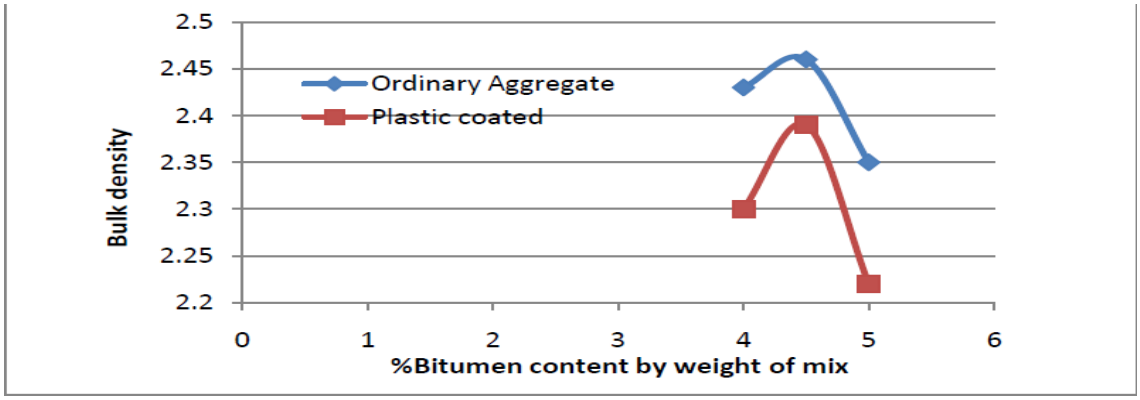


Fig.8 Variation of %VFB with % bitumen content by weight of mix



The optimum bitumen content is calculated by taking the average of the following bitumen contents found from the respective graphs.

- Bitumen content corresponding to maximum stability
- Bitumen content corresponding to maximum unit weight
- Bitumen content corresponding to the median of designed limits of percentage voids (Vv) in the total mix.

The value of optimum bitumen for the bituminous mix content is:

- Ordinary aggregate mix **4.659%**
- Plastic coated aggregate mix **4.584%**

IV. CONCLUSION

The results indicated that the consumption of waste polythenes in bituminous concrete mixtures shows improved property of the mixtures thus formed. The waste polythene consumed in the mix will get coated over aggregates of the mixture and reduces porosity, absorption of moisture and improves binding property. The bitumen modified with 4.5 % Polythene Waste is showing better performance as compared to

other mixes. The Marshall Stability which is a strength parameter has shown increasing trend with a maximum increase percent of 35.20% as compared to Conventional mix when modified with 4.5 % Polythene Waste. It is observed that Marshall Stability value increases with polythene content up to 4.5 % and thereafter decreases. Thus the use of higher percentage of waste polytheneis not preferable. While talking to environmental pollution due to these non-biodegradable plastics waste where disposal of such materials has become a serious problem, its use in construction of flexible pavement will give a better place for their burying and thus solving the problem of their disposal on one hand and providing a better flexible pavement with improved performance on other hand. The properties of aggregates which mainly cause rutting action are improved using plastic coated aggregates. Considerable increase in Marshall Stability value & the optimum bitumen content is also reduced. Above all the waste plastic which is a pollution menace can find its use in road construction and thereby solving the problem of pollution to a certain extent.

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