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"EXPERIMENTAL STUDY ON EFFECT OF WASTE PLASTIC ON BITUMINOUS MIX PROPERTIES"

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ABSTRACT

The amount of plastic waste disposal is increasing day- by- day and it's a serious problem causing environmental pollution as it is non-biodegradable. This plastic waste like Polyethylene, Polypropylene and Polystyrene are mainly used for packing. On the other side, the road traffic is increasing day- by- day. The load bearing capacities of the road are to be increased. The use of Plastic Coated Aggregate for asphalt pavement helps for the reuse of plastics waste and for the improvement of road strength and durability of the pavement. In this paper an attempt is made to use the waste plastic like low density polyethylene (milk pockets), to coat the aggregate, in bituminous mix and the properties such as density, stability, flow, air voids are investigated. Also the optimum bituminous mix, using plastic coated aggregate, is compared with ordinary bituminous mix. Since the softening point of these plastics varies between 110^0C-140^0C and they do not produce any toxic gases while heating, but the softened plastic forms a thin film like structure over aggregates, when it is sprayed on hot aggregate which is heated at 160^0C. Plastic coated aggregate bituminous mix showed improved binding property and stability value .This method is eco-friendly and economical too.

***Keywords**:* Plastic coated aggregate bituminous mix, density, stability, air voids, low density polyethylene.

1. INTRODUCTION

Plastics, a versatile packing material and a friend to common man, become a problem to the environment after its use. Finding proper use of the disposed plastics waste is the need of the hour. The plastics used such as bags, cups, films and foams, made up of PE, PP or PS. Around 55% is being used for packing. They are mostly littered after their use. The littered plastics, a non biodegradable material, get mixed with domestic waste and make the disposal of municipal solid waste difficult. The municipal solid waste is either incinerated or used for land filling. Both are not right techniques to dispose the waste and it will create both land and air pollution.

On the other side, the road traffic is increasing day- by- day. The load bearing capacities of the road are to be increased. The use of PCA for asphalt pavement helps for the reuse of plastics waste and for the improvement of road strength and durability of the pavement. The plastic roads are better than conventional roads. Disposal of plastic wastes in an eco friendly way is the thrust area of today's research.

2. LITERATURE REVIEW

Bindu et al explains benefits of stabilizing the stone matrix asphalt in flexible pavement with shredded waste plastic.

S.Rajasekaran et al. showed that the plastic coated aggregate bituminous mix shows better binding property and hence better stability.

Amit Gawande et al. found that the use of waste plastic in road construction as an effective way to reutilize the plastic waste.

Justo et al. observed that the modified bitumen shows better performance when compared to ordinary bitumen. The properties such as penetration and ductility values of modified bitumen decreased with increase in plastic content up to 12%by weight of bitumen.

3. MATERIALS AND PROPERTIES

Materials used for the current project are

3.1. Aggregates

Aggregates were obtained from local quarry and properties were tested in the laboratory and are given below,

Table 1: Aggregate properties

Tests	Results
Impact test	21.80%
Los angels abrasion test	24.23%
Combined index	32%
Specific gravity of 20mm downsize 12.5mm downsize	 2.6 2.56
Water absorption of 20mm downsize 12.5mm downsize	 0.36 0.54
Crushing strength	23.07%

3.2. Bitumen

VG-30 bitumen was obtained from MRPL and the basic tests were done .The results are as shown below,

Table 2: Bitumen properties

Tests	Results
Penetration test	65
Ductility test	74
Specific gravity	0.99
Softening point test	53

3.3. Filler

Ordinary Portland cement (OPC) was used as filler material. Specific gravity of OPC is 3.15

3.4. Waste plastic (LDPE)

Milk pockets were collected, cleaned and dried then they were shredded to pieces of less than 5mm and then they were used for the coating of aggregate in the bituminous mix.

4. AGGREGATE GRADATION:

The gradation of the mix used for the preparation of Bituminous concrete grade-2 are as shown in Table 3 which satisfies MORTH IV revision.

Table 3: Aggregate gradation

Sieve size, mm	Specified % passing as per MORTH IV revision	Adopted % passing
19	100	100
13.2	79-100	90
9.5	70-88	79
4.75	53-71	62
2.36	42-58	50
1.18	34-48	41
0.6	26-38	32
0.3	18-28	23
0.15	12-20	16
0.075	4-10	7

5. DETERMINATION OF OPTIMUM BITUMEN CONTENT

In order to find out the optimum bitumen content, Marshal Method of mix design was adopted. Aggregate gradation was adopted as bituminous concrete grade-2.For every percentage of bitumen content three samples were prepared , tested and average value was taken .The properties of the compacted specimens are calculated. From the results, the optimum bitumen content was found to be 5.2%.

Table 4: Marshal tests results for optimum bitumen content

Bitumen content	Bulk density (g/cc)	Bulk specific gravity	VMA (%)	Va (%)	Stability (KN)	Flow (mm)	Vfb (%)
4.5	2.3	2.6	15.52	5.37	10.8	2.32	65.38
5	2.31	2.6	15.6	4.27	13.6	2.54	72.6
5.5	2.34	2.6	14.95	2.33	12.2	2.9	84.4
6	2.33	2.6	15.76	2.06	11.6	3.3	86.96
6.5	2.32	2.6	16.57	1.78	10.3	3.9	89

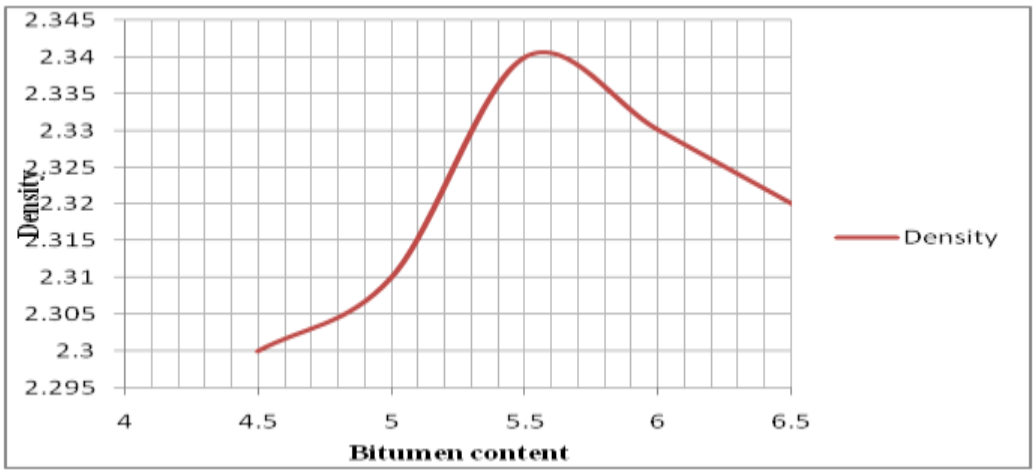

Fig 5.1 shows Bitumen content versus Density

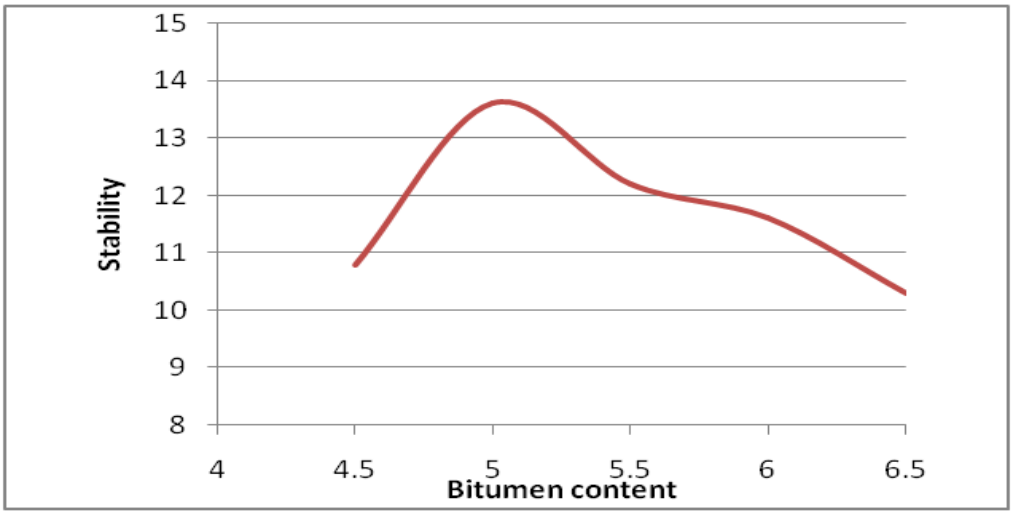

Fig5. 2 shows Bitumen content v/s Stability

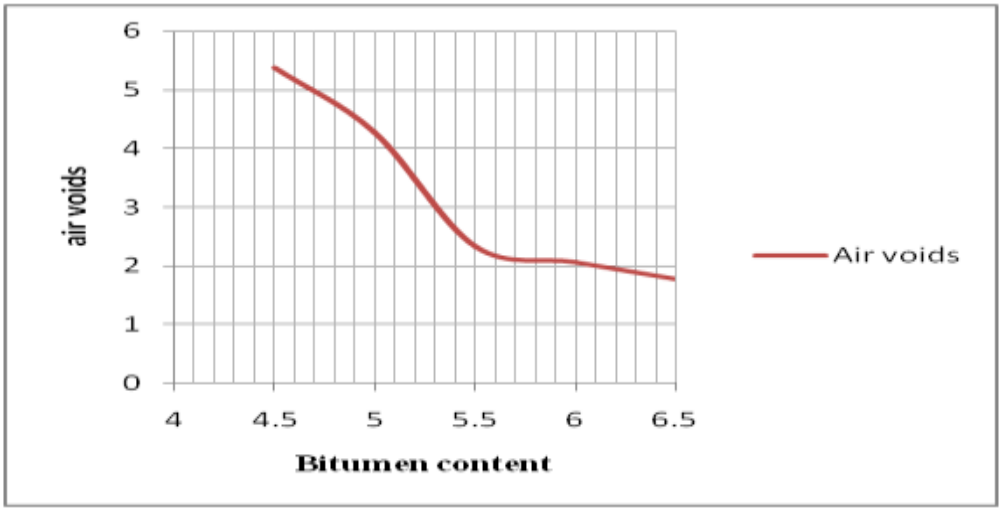

Fig 5.3 shows Bitumen content v/s Air voids

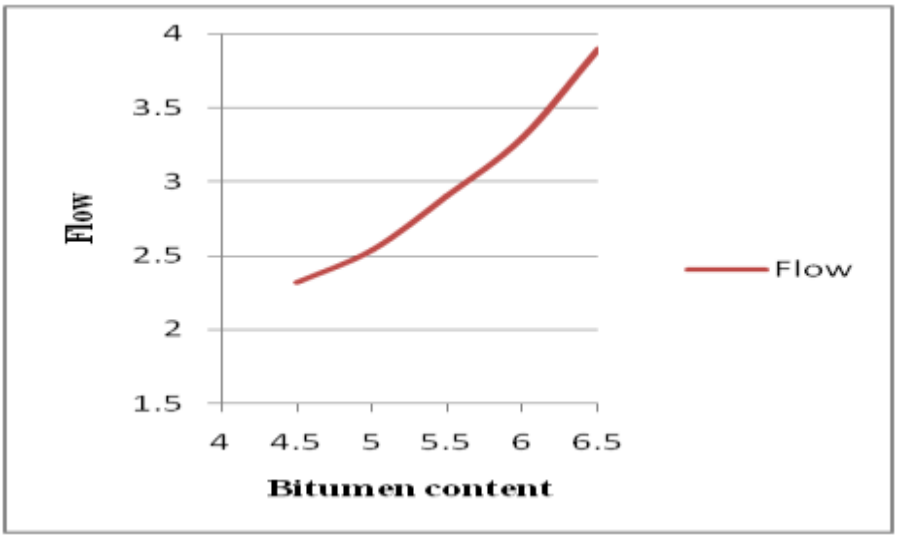

Fig 5.4 shows Bitumen content v/s Flow

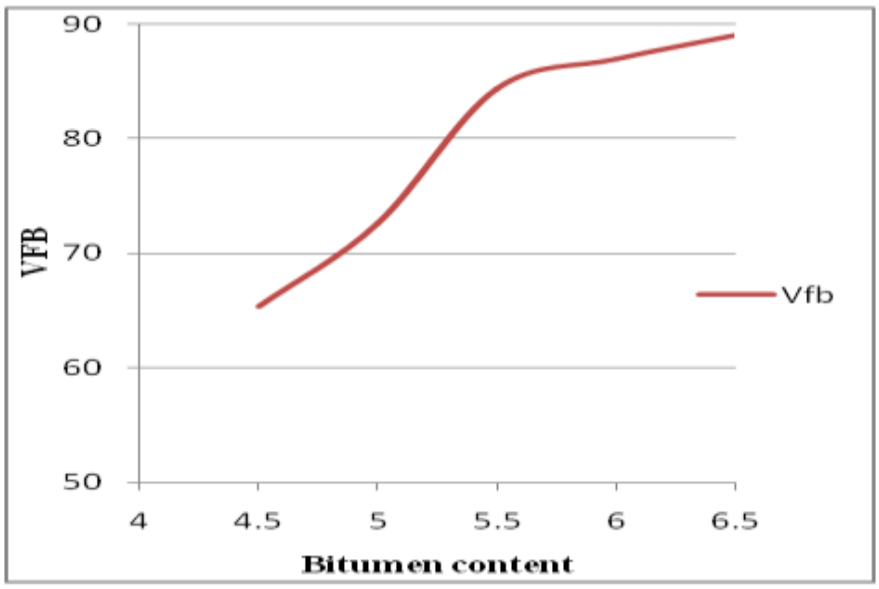

Fig 5.5 shows Bitumen content v/s Vfb

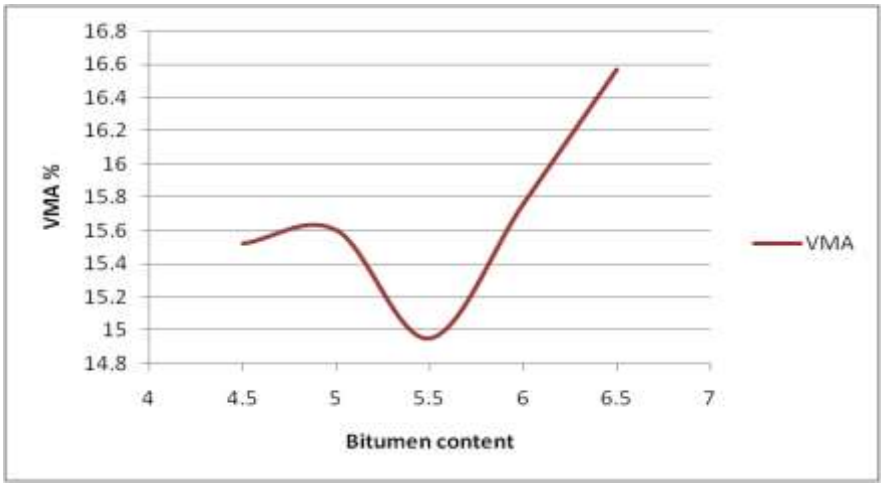

Fig5.6 shows Bitumen content v/s VMA

6. VARIATION OF MARSHAL PROPERTIES WITH PLASTIC CONTENT.

Marshal method was adopted to find optimum plastic content. The plastic content was increased by 2% (by weight of aggregate) to coat aggregate and for every percentage three samples were prepared, tested and average value was taken. The properties of the compacted specimen were noted and analyzed. Up to 4%, the properties were improved. The percentage of plastic at which the stability is maximum and flow value is minimum is taken as optimum plastic content. Hence 4% is optimum plastic content.

Table 5: Marshal properties with plastic content

Plastic content	Bulk density (g/cc)	Bulk specific gravity	VMA (%)	Va(%)	Stability (KN)	Flow (mm)	VFB (%)
0	2.28	2.6	16.69	5.29	13.2	4.1	68.29
2	2.26	2.56	16.13	4.83	14.35	3.2	70.04
4	2.23	2.52	15.93	3.95	15.6	2.8	69.98
6	2.19	2.48	16.10	6.3	13.68	2.89	67.97

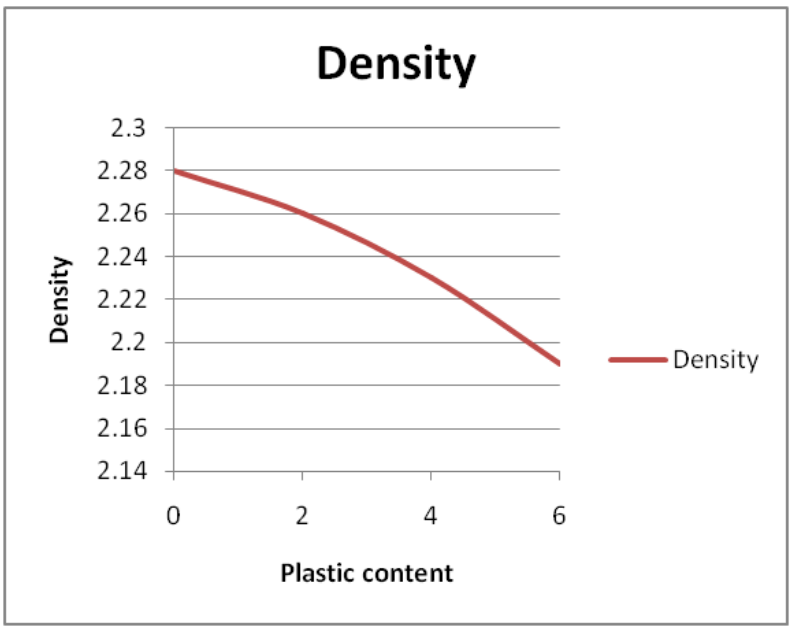

Fig 6.1 shows plastic content v/s Density

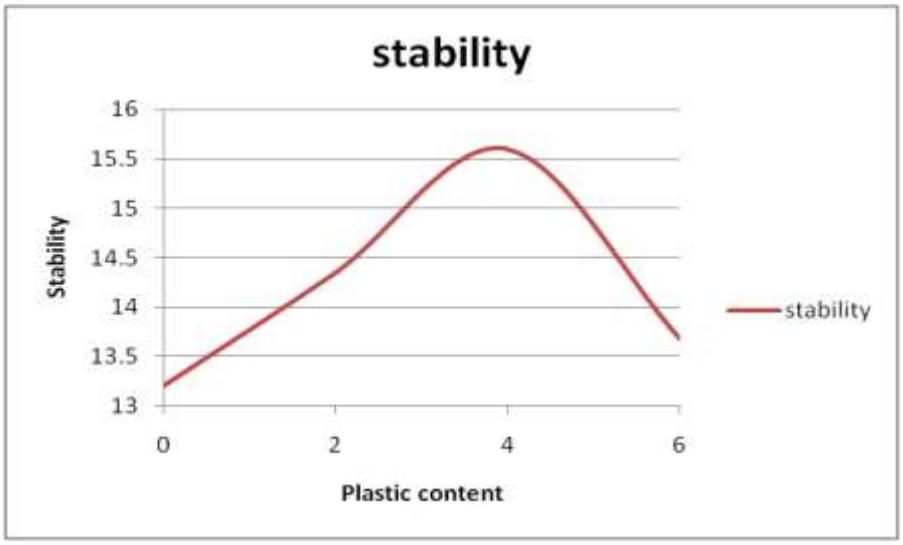

Fig 6.2 shows Plastic content v/s Stability

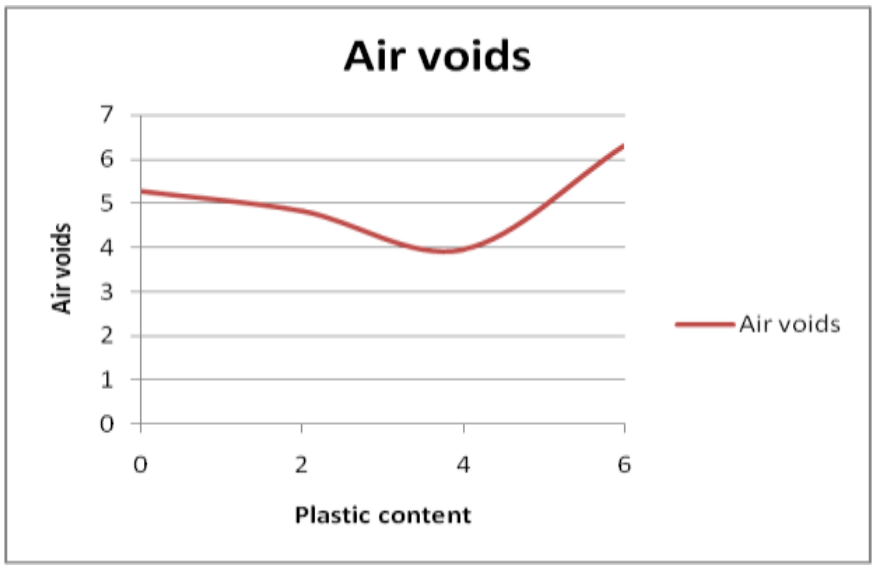

Fig 6.3 shows Plastic content v/s Air voids

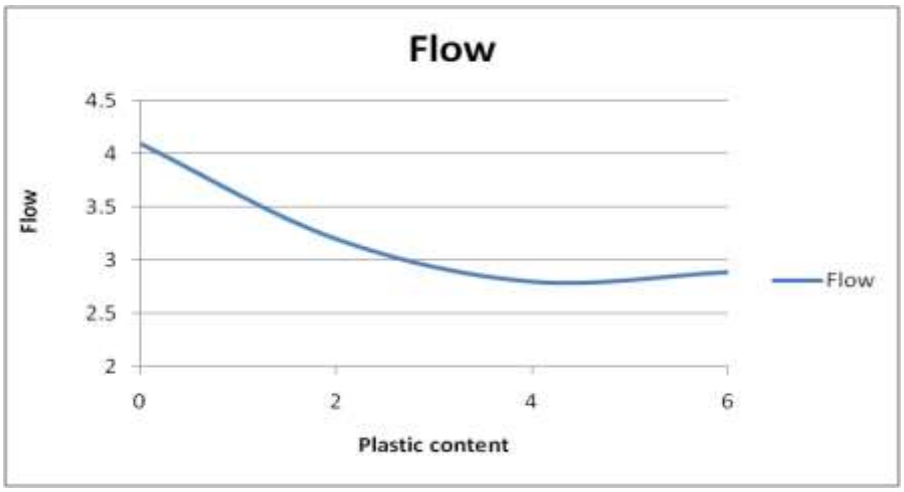

Fig 6.4 shows Plastic content v/s Flow

7. FINDING OPTIMUM BITUMEN CONTENT AT OPTIMUM PLASTIC CONTENT

Here also Marshal Mix method was adopted .Keeping optimum plastic content as constant and bitumen content is varied from 4 to 5.5% and specimens were prepared and tested. For each percentage of bitumen content 3 specimens were casted, tested and average value was taken. From the result of the test it is observed that the optimum bitumen content was reduced. The optimum bitumen content at optimum plastic content was found to be 4.7%.

Table 6: Marshal properties at optimum plastic content

Plastic content	Bitumen content	Density (g/cc)	Stability (KN)	Va %	Vma %	Vfb %	Flow(mm)
4	4	2.243	11.2	5.03	12.95	61.1	3.93
4	4.5	2.25	14.3	4.06	13.5	69.89	4.25
4	5	2.26	10.9	2.83	14	79.73	4.7
4	5.5	2.49	10.3	2.85	13.8	79.3	5.02

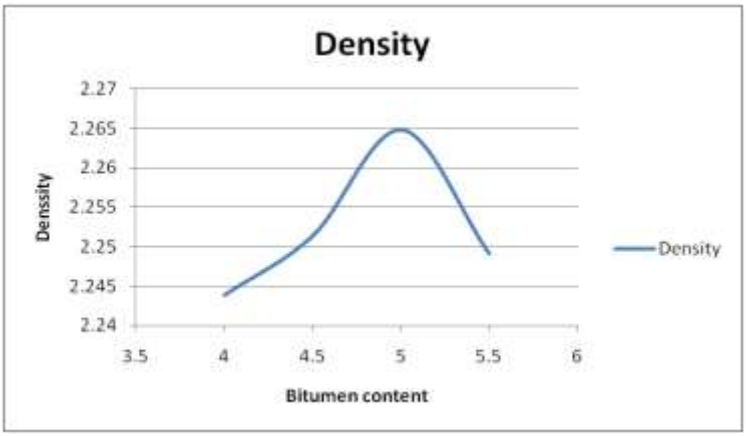

Fig 7.1 shows Bitumen content v/s Density at OPC

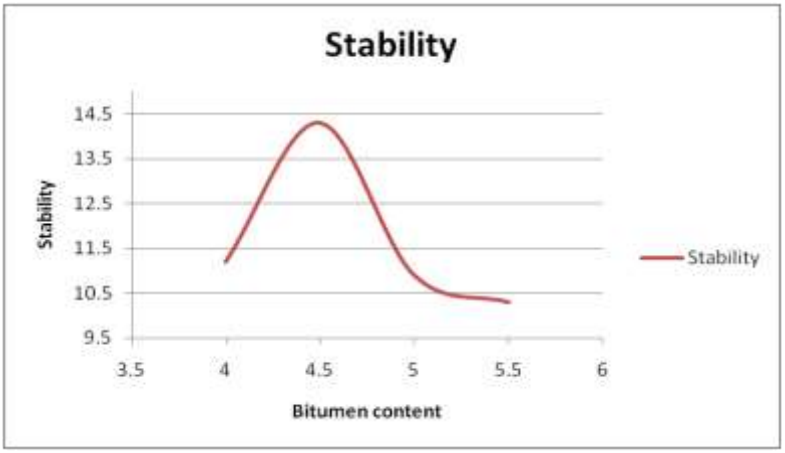

Fig 7.2 shows Bitumen content v/s Stability at OPC

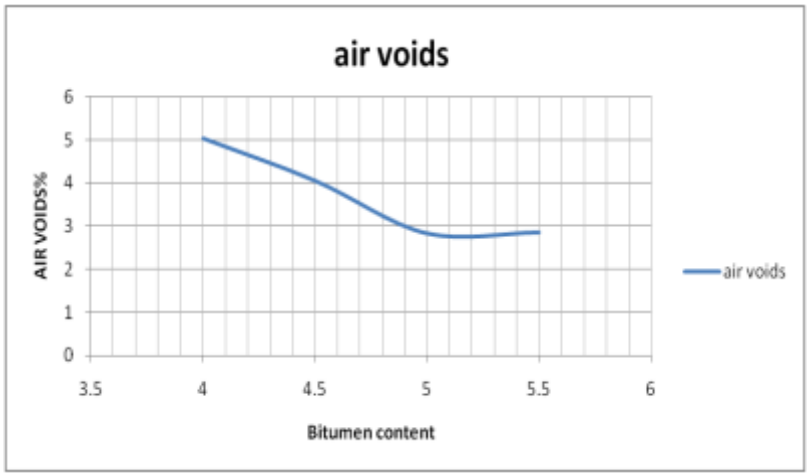

Fig 7.3 shows Bitumen content v/s Air voids at OPC

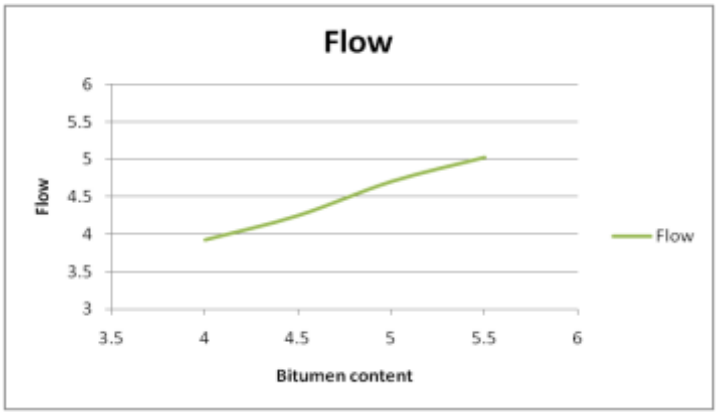

Fig 7.4 shows Bitumen content v/s Flow at OPC

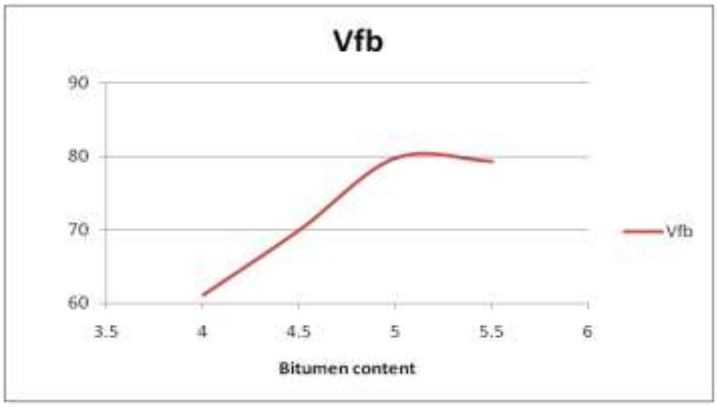

Fig 7.5 shows Bitumen content v/s Vfb at OPC

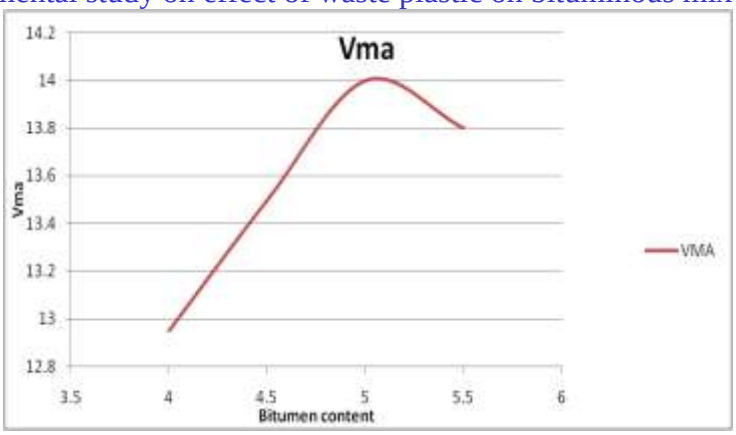

Fig 7.6 shows Bitumen content v/s Vma at OPC

8. CONCLUSION

1. Since the plastic waste disposal is a serious problem now a days and it will cause environmental pollution. Hence it's a better way to make use these wastes in the road construction as it shows better adopting ability with the aggregate, bitumen and mix.
2. Improved in the Marshal properties can be observed up to 4%.
3. The optimum bitumen content can be reduced.
4. Eco- friendly.

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