A STUDY ON BEHAVIOUR OF ADDITION OF WASTE PLASTIC IN BITUMINOUS CONCRETE MIX WITH STONE DUST AS A FILLER

Prof. Priyadarshini H P [1], Prof. Gunasheela P [2], Prof. Sharmila H C[3]

[1] *Assistant Professor, Civil Engineering Department, R. R. Institute of Technology, Karnataka, India*

[2]*Assistant Professor, Civil Engineering Department, R. R. Institute of Technology, Karnataka, India*

[3]*Assistant Professor, Civil Engineering Department, R. R. Institute of Technology, Karnataka, India*

ABSTRACT

Roads plays a very important responsibi1ty in growth of infrastructure. Conservation natural resources and preservation of environment is necessary thing. Rapid growth of population, urbanization and industrialization has resulted the generation of huge quantity of wastes, both solid and liquid industrial waste. In the present study waste plastic will be added with percentage by volume of bitumen (5%,7.5%,10%,12.5% and 15%) and stone dust as filler materials. The strength parameters such as stability test by using Marshall Stability apparatus. Based on test appropriate results will be derived for conventional 14.55 kN strength obtained wen adding of 12.5% of waste plastic 21.75 kN of stability obtained.

Keyword: - *Bitumen, Waste plastic, Stone dust, Marshall Stability*

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1. INTRODUCTION

All types of Roads are refers to the mode of transportation. There are 4 modes of transportation. i.e. road ways, railways, air ways and water ways and 2 minor roadways i.e., Rope ways and pipelines. R0ad ways used for the transportation purpose, because home to home services due to less cost and easily availability of vehicle for all types people. So that the roads should be resisting the repeated wheel loads and it should be maintained in good condition. So more usage of roads and we should impr0ve the road quality by using industrial and agricultural waste by adding to Bitumen and aggregate. Waste plastic is waste material which cannot be burn and it won't decompose in earth. This waste product is already causing, environmental pollution. The present study includes the characteristic of bitumen modified by plastic with stone dust as filler material in BC. Tests are conducted for the basic materials. Marshall Tests are conducted to find the OBC. To find OPC in BC, waste plastics are added in different percentages i.e. 5%, 7.5%, 10%, 12.5% and 15% by weight of bitumen with stone dust as filler the behaviour of plastic with stone dust as filler is studied by comparing the properties of BC mixes.

2. OBJECTIVE OF STUDY

The objectives of project are to make a synergic effect for Bituminous Mix (BC) and Stone dust incorporated in bitumen to study the behavior of waste plastic adding to bitumen and stone dust as filler.

1. To evaluate the basic properties of aggregates, bitumen and filler material.
2. To obtain the Optimum Bitumen Content (OBC) for BC based on the Marshall test properties.
3. To obtain the Optimum Plastic Content (OPC) for DBM based on volumetric properties when waste plastic is varied and stone dust is used as mineral filler.
4. To find OPC of BC modified by different percentage of waste plastic and stone dust as filler material.
5. Comparing the characteristics of BC modified by plastics with stone dust as filler with control mix.

3. LITERATURE REVIEW

Shweta et.al study was carried out by Use of waste plastic in road construction modification is done by using the method of wet process. 2.36 mm is size of plastic were used in experiment. The waste plastics were coated with aggregates the waste plastic is varied from 10% to 40% with increment of 10%. The bitumen was heated up to 160^0C to get the proper binding of mix. When the plastic is added to aggregates at 10% the compressive strength is

250MPa and bending strength is 325MPa, with increasing the waste plastic the compressive and bending strength were increased at 40% 320MPa compressive strength and 390 bending strength.

Verma (2008) studied that plastic increases the melting point of the bitumen and makes the road flexible during winters resulting in its long life. According to author while a normal "highway quality" road lasts four to five years, plastic-bitumen roads can last up to 10 years and it 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 big potholes.

Khan and Gundaliya (2012)., stated that the process of modification of bitumen with waste polythene enhances resistance to cracking, pothole formation and rutting by increasing softening point, hardness and reducing stripping due to water, thereby improving the general performance of roads over a long period of time. According to them the waste polythene utilized in the mix forms coating over aggregates of the mixture which reduces porosity, absorption of moisture and improves binding property.

Swami et al. (2012) investigated that the total material cost of the project is reduced by 7.99% with addition of plastic to bitumen between the ranges of 5% to 10%. They concluded that by modification of bitumen the problems like bleeding in hot temperature regions and sound pollution due to heavy traffic are reduced and it ultimately improves the quality and performance of road.

4. MATERIALS AND RESULT DISCUSSIONS

4.1 Bitumen

Bitumen is by product material obtained during of petroleum refining. Bitumen is a complex and highly viscous, for the room temperature it is in solid form. Bitumen is fills the voids and binds with the aggregates together. Due to the binding property and flexibility behavior with aggregates it used for the road construction. The grade of bitumen were used 60/70mm.

Table-1 Test Results for Bitumen

Sl. No	Test	Test methods	Results
1	Penetration	IS 1203-1978	68mm
2	Ductility 27^0	IS 1208-1978	72cm
3	Specific Gravity	IS 1202-1978	0.96
4	Softening Point ^oC	IS 1205-1978	51^0C

4.2 Aggregates

Aggregates are important constituents in road and they constitute 70-80% total volume. They increase the strength at great extent. As aggregates are main part of a body in different modes of transportation. The coarse aggregate are granular materials obtained from rocks and crushed stones.

Stone Dust: The stone dust is obtained crushing of aggregates which is finer than 0.075mm. It is an industrial waste product and usually dumped in land area. It is used as filler materials in road construction.

Table- 2.Gradation of aggregate in bituminous concrete

MORTH 5th Revision	% passing by weight		Cumulative retain %	Individual retain %	% of Coarse aggregate, fine aggregate, filler	Individual weight of 1200gm
Sieve mm	Grading	Blend				
26.5	100	100	00	00	55%	00
19	90-100	95	05	05		60
13.2	59-79	69	31	26		312

9.5	52-72	62	38	07		84
4.75	35-55	45	55	17		204
2.36	28-44	36	64	09	40%	108
1.18	20-34	27	73	09		108
0.6	15-17	16	84	11		132
0.3	10-20	15	85	01		12
0.15	5-13	09	91	06		72
0.075	2-8	05	95	04		48
Filler					5%	60
Total weight of aggregates for sample					**100**	**1200gm**

Table-3 Test on Coarse aggregate

Tests	**Test methods**	**Results**	**MORTH Specifications**
Los Angeles Abrasion	IS:2386(III)	24.22%	35% maximum
Water Absorption	IS:2386(IV)	0.81%	2% maximum
Impact value	IS:2386(IV)	14.06%	27% maximum
Specific Gravity	IS:2386(III)	2.67%	–
Flakiness Index and elongation index	IS:2386(I)	30.15%	35% maximum

4.3 Waste P1astic

In this project work Polypr0pylene were used as additive. Packaging covers (used to packing of parcel) are collected from municipal solid waste and washed initially and dried. Then they are cut into pieces manually. The size of shredded plastic is varied between the 4.75 to 2.36 mm. In present work plastics were used 5%, 7.5%, 10%, 12.5% and 15% by weight of bitumen by increasing 2.5%. The specific gravity ofpolypropylene is 0.905.

Fig-1 Waste plastic in shredded form

5. MARSHALL STABILITY TEST

Marshall Stability test procedure involves preparation of samples with standard procedure i.e. proportion of materials, heating and mix of materials, compaction of mixture with bitumen. The main objective of Marshall Stability test is to resist the flow of cylindrical specimen under loading.

Table -4 Standard requirement of BC mix as per MORTH [5 th Revision]

Properties	Requirement
Marshal Stability (KN)	9
Compaction level for heavy traffic	75 blows on each side
Flow value (mm)	2 – 4
Volume of Air voids (V_v),%	3 – 5
VFB (%)	65 – 75
VMA (%)	Minimum14

Fig-2(a) Marshall sample mix **2(b) Marshall Specimen**

Fig-3 Marsha11 stability Test apparatus

5.1 MARSHALL PROPERTIES OF CONVENTIONAL BITUMEN MIX

Marshall Property for optimum bitumen content is to capacity of a mix to fulfill stability, flow and volumetric properties of bitumen mix. In this study Marshall Method mix design is used and MORTH specifications are followed. The grade of bitumen used is 60/70. The results of test conducted to find the optimum bitumen content of the BC mix are tabulated in Table 4

Table-4 Properties of BC mix for OBC stone dust as filler

Property Tested	Bitumen content by Weight of aggregates					
	4.5%	5%	5.5%	6%	6.5%	7%
Marshall Stability (KN)	7.31	11.08	14.55	12.19	11.16	7.235
Flow Value (mm)	2.23	2.86	3.42	3.6	3.99	4.2
Bulk density (g/cc)	2.31	2.34	2.37	2.36	2.34	2.34
Volume of voids Vv (%)	6.85	4.87	3.26	2.88	2.90	2.09
VMA (%)	17.67	17.05	16.83	17.63	18.74	19.15
VFB (%)	61.23	71.43	80.62	83.66	84.52	89.08

From the Table-4 maximum stability is obtained at 5.5% bitumen content. Bulk density is obtained at 5.5% of bitumen content. Air voids at the 4% at the 5.24% of bitumen content. Graphs are plotted for each characteristic. The OBC is 5.4% ((5.5+5.5+5.24)/3=5.41%) for BC mix.

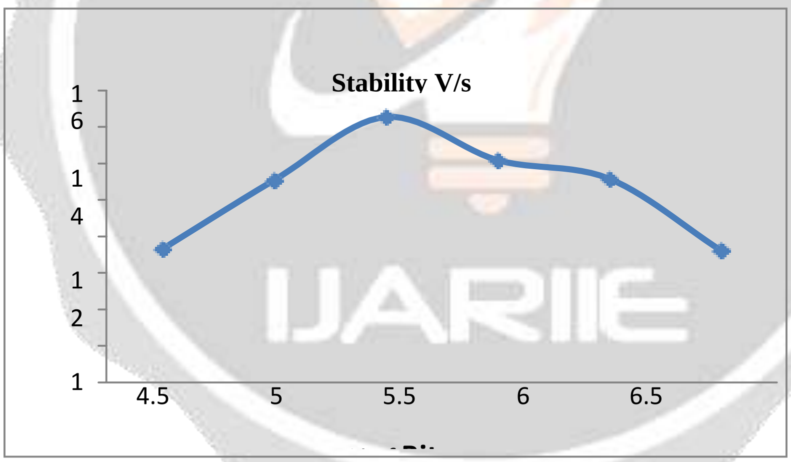

Fig -3 Bitumen content v/s Marshall Stability for BC mix

Figure 3 shows the results of Marshall Stability test at the OBC. The maximum stability is obtained at the 5.5% of bitumen content. After 5.5% the increasing in bitumen content stability value is decreases. When increasing the bitumen content stiffness will increases.

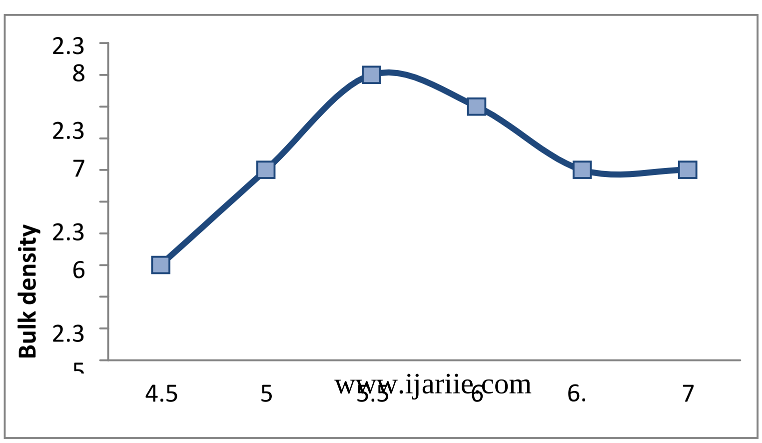

Fig-4 Bitumen content v/s bulk density for BC mix

It is observed that Fig 4 variation in bulk density when increasing the percentage of bitumen content. Initially the value is decreases at the 5% of bitumen content, after the increasing. The variation is due to increase the percentage of bitumen content.

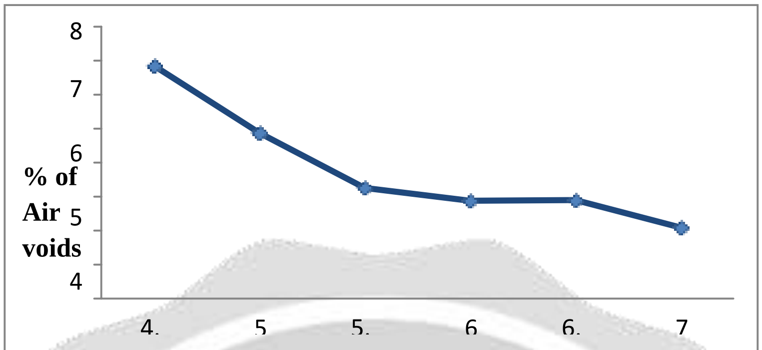

Fig-4 Bitumen content v/s Air voids (Vv)

From Fig 4 the air voids is satisfied MORTH specification at the 4.5% bitumen content. At 5% of bitumen content the air voids is increased. Air voids is decreasing due to increase in bitumen content. It shows the proper compaction and voids is filled with bitumen.

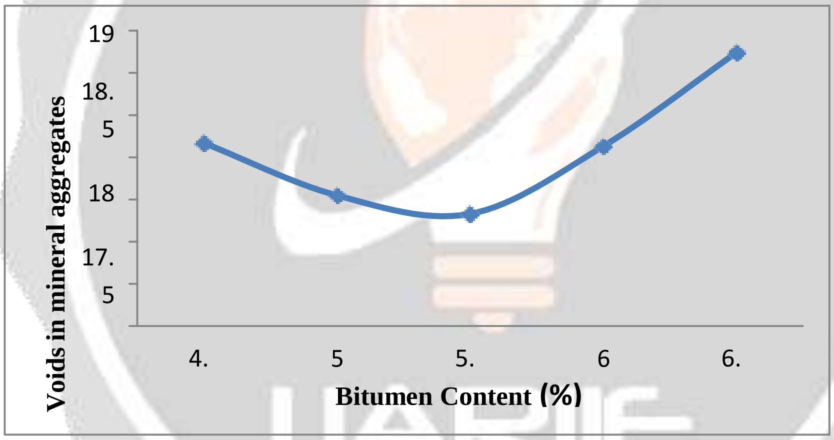

Fig-5 Bitumen content v/s Voids in mineral aggregates

From Fig 5 shows that VMA is increasing up to 5% of bitumen content. After 5% it decreases because increasing in bitumen content. Bitumen fills the voids between aggregates. When increasing the VMA 5% to 7% of bitumen content it represents the low mixture of stability.

5.2 MARSHALL PROPERTIES OF BC MIX FOR WITH WASTE PLASTIC AND STONE DUST AS FILLER

The additive is thin packaging waste plastic added to bitumen is stone as filler. Increase in plastic content variation in bulk density. The air voids is gradually decreasing, when increasing the plastic content up to 12.5% and it satisfies the MORTH speciation (3-5). VMAis satisfied MORTH (minimum14) and VFB is within in the specified range (65-75). The Marshall stability is increased at 10.0% plastic content. Based on the volumetric properties and Marshall Stability value the optimum plastic content is 10.0% with stone dust as filler. The volumetric properties results are tabulated in table 5.2. The graphs are plotted.

Table-5 Properties of BC mix plastic with stone dust as filler

Property Tested	**Percentage of plastic by weight of bitumen**				
	5%	**7.5%**	**10%**	**12.5%**	**15 %**
Marshall Stability (KN)	11.53	14.5	16.61	21.75	15.73
Flow Value (mm)	2.2	3.5	4.3	4.7	5.6
Bulk density (gm/cc)	2.273	2.281	2.322	2.352	2.310
Air Voids V_V (%)	6.958	6.439	4.562	3.090	4.702
VMA (%)	19.743	19.269	17.623	16.320	17.695
VFB (%)	64.75	66.58	74.11	81.06	73.42

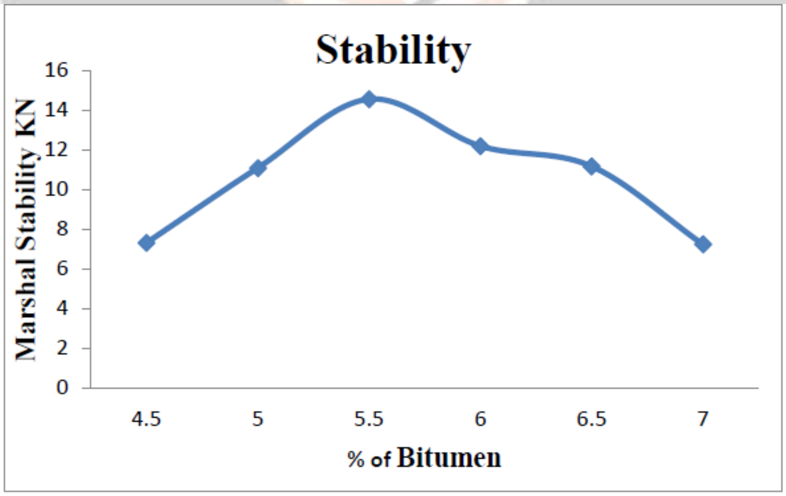

Fig-6 Plastic content v/s Marshall Stability for BC mix stone dust as filler

Fig -6 shows the Marshall Stability for BC mix with stone as filler. The stability value is goes on increasing when the plastic is added in different percentage. The maximum stability 17.23 KN is achieved at the 10% plastic content. After that is decreasing, when compared to the conventional mix the stability is high. As per MORTH minimum stability value is 9kN. The flow value is increasing when increasing the percentage of plastic content. The flow value is depends on stability value.

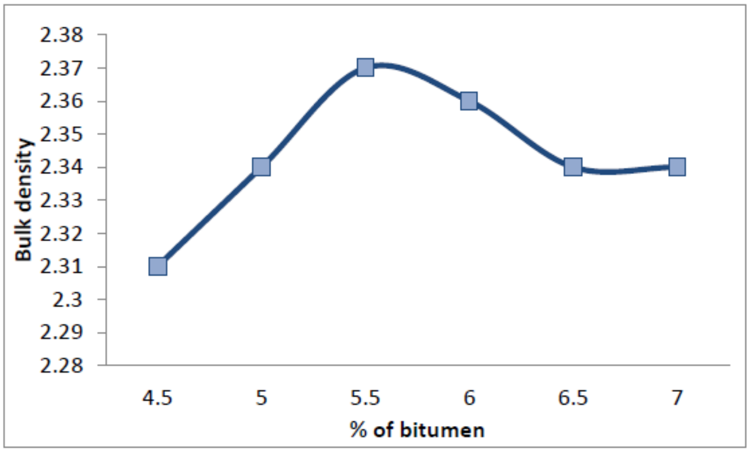

Fig-7 Plastic content v/s Bulk density for BC mix stone dust as filler

It is observed that Fig-7 the bulk density is increases when increasing in plastic content in BC mix. The maximum bulk density is 2.3521 g/cc at the 12.5% of plastic content. When the percentage of plastic increases the bulk density increases with 5.4% of bitumen content. Bulk density is depends on weight of aggregates, weight of percentage of plastic content added for the mixture.

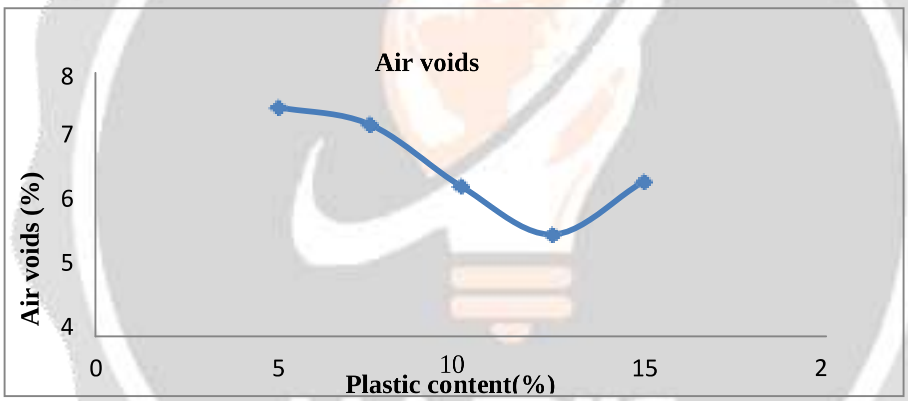

Fig-.8 Plastic content v/s Air voids for BC mix stone dust as filler

Fig- 8 shows that when increasing in plastic content the air voids is decreasing. When compared to conventional mix the air voids is more due to bonding between the aggregates of bitumen and plastic content. The air voids is satisfied as per MORTH specification at the 12.5% (5.24) of plastic content. The decreases in air voids shows the stability of mix is improving when increase the percentage of plastic.

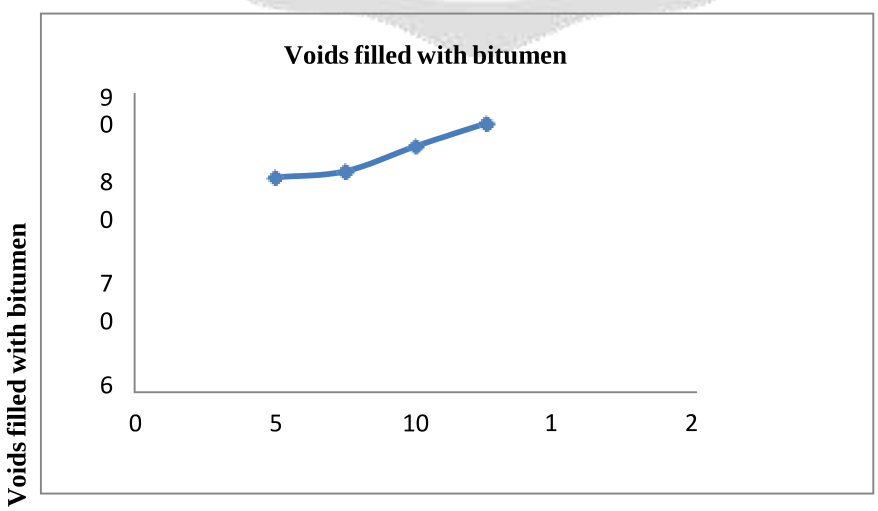

Fig-9 Plastic content v/s Voids filled with bitumen for BC mix stone dust as filler

It is observed that from Fig-9 increasing with VFB, increasing in plastic content in DBM mix. Plastic content at 10.0% the value of VFB is 74.11%, it is satisfies the MORTH specification (65-75). When compared to the conventional mix when plastic get mixed with stone dust as filler. At 15% the VFB value is decreases due to plastic have good binding property

6. CONCLUSION

The study was carried out on the waste plastic coated with aluminum layer with stone dustand bagasse ash as fillers. The waste plastic was added 5% to 15% with increment of 2.5% byweight of bitumen. Following conclusions are derived based on the Marshall stability of conventional mix, modification of waste plastic with stone dust in BC mix.

- The basic tests were conducted for aggregates and bitumen satisfies the IS codes, so itused for the study.
- Based on the Marshall Stability, air voids and bulk density the Optimum Bitumen Content (OBC) in BC mix is 5.41%.
- The Optimum Plastic Content (OPC) in BC mix with stone dust as filler is 11.15%. The Marshall stability with the addition of waste plastic and stone dust filler, the maximum stability is obtained at 10.0% of plastic content is 17.23KN.
- Compare the stability the addition of plastic is more than the conventional BC mix i.e 14.55 KN for conventional BC mix and 17.23 for modified BC mix.
- Addition of waste plastic improves the strength of BC mix, hence recommended touse waste plastics in construction which reduces the disposal and the environmental problems.

7. REFERENCES

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