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Determine the Marshall Stability and Flow Parameters of Semi Dense Bituminous Concrete Mixed with Waste Plastic

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Abstract: ***Flexible pavement road is laid in most part of the India as it is cheaper then rigid pavement and provide better performance in mixed traffic condition. Bituminous concrete is used for the pavement construction of flexible roads. Plastics are widely adopted by our society as it gives sufficient strength at cheaper Cost but on another hand it is harmful to the environment as it is not biodegradable. The only method to dispose the plastic is to incinerate it or filling land by it, which are very harmful to the environment. Plastic (both from domestic and industries) can be used in the production of bitumen aggregate mix. the melting point of plastic varies from 100° C to 150°C and no harmful gases are release during heating .On melting, when it spread over the aggregate at 150° C it has a tendency to make a film over the surface of the aggregate. Plastic painted aggregate (PPA) – bitumen mix has the good marshal stability and load bearing capacity value also road pavement made by PPA Bitumen mix has the better water resistant property. The aim of this study to use the PPA- bitumen mix in road pavement construction and analyze the value of marshal stability on different percentage content of plastic.***
Keywords: Marshall Stability, flexible pavements, PPA plastic painted aggregate, bituminous concrete.

I. INTRODUCTION

India, comes at 2nd position in case of road length in world, has 59 lack kilometer road network. Flexible pavement road is laid in most part of the India as it is cheaper then rigid pavement and provide better performance in mixed traffic condition. Bituminous concrete is used for the pavement construction of flexible roads. There is continuous increase in traffic and maintenance expenditure of roads from last few decades. Price of crude oil is also increasing day by day due to which price of bitumen is also increased. That's why there is need of updated technology and economical construction of roads. So that construction of road can be done with available fund and constructed road can fulfill all the requirements of road users. It is found from the study in India and abroad that if plastic is used in road construction, it improves the strength as well as cut the cost of construction. Use of plastic in road construction can also reduce the problem of disposal of waste plastic. Plastics are widely adopted by our society as it gives sufficient strength at cheaper Cost but on another hand it is harmful to the environment as it is not biodegradable. India generates 5.6 million tone plastic waste per annum. One of the very bad thing related to plastic is that it is use and throw material. In India waste tyres are incinerated in almost urban and rural areas they become the cause of air pollution. Improper disposal of plastic can produce many dieses among peoples.

The only method to dispose the plastic is to incinerate it or filling land by it, which are very harmful to the environment. Plastic (both from domestic and industries) can be used in the production of bitumen aggregate mix. the melting point of plastic varies from 100° C to 150°C and no harmful gases are release during heating .On melting, when it spread over the aggregate at 150° C it has a tendency to make a film over the surface of the aggregate. Plastic painted aggregate (PPA) – bitumen mix has the good marshal stability and load bearing capacity value also road pavement made by PPA Bitumen mix has the better water resistant property. Bitumen aggregate mix contain aggregate 92 to 95 % by weight which bear all the load coming from vehicle tyres. Mixing of plastic in bitumen increase the softening point reduce the penetration value at suitable ductility. Aggregate coated with plastic when mixed in bitumen can withstand high temperature and traffic load and also reduce porosity and water absorption. It cuts the need of bitumen by 12% and thus reduce the cost of construction of road.

Plastic is used in road construction in India since 2000. In this study it is proved that how plastic can improve the marshal stability value and provide better pavement performance. Different percentage of plastic is added in bituminous mix and marshal stability value is analyzed.

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II. LITERATURE REVIEW

some research are carried out on the modification of bitumen by mixing low density plastic into it, to increase the strength of the pavement.

Brajesh Mishra and Ravi Shankar Mishra (2015) proves that waste plastic is the best modifier. It makes a plastic layer on the surface of the aggregate and thus reduce porosity, water absorption and also improves binding properties of bitumen.

Swami et al. 2012 [2] studies that when plastic is mixed in bitumen it absorbs sound coming from the heavy traffic, in this way it reduces sound pollution. The optimum plastic is in the range between 5% - 10%.

Pratiksha Singh and Rajput R. K. Yadav (2016) studied that when 12 % plastic by weight of bitumen is mixed in bitumen aggregate mix the marshal stability value is maximum.

Rokade S (2012) studied that the use of LDPE & CRMB in the mix shows the increasing trend of Marshal Stability values about 25%. It also increases the density of the mix. when compared with 60/70 grade bitumen.

Sasane et al. (2015) studied that mixing of plastic in bitumen and aggregate mix increases the properties of aggregate and bitumen. The value of optimum plastic is 10%.

III. METHODOLOGY

First some physical tests on bitumen and aggregates were carried out and then to prepare the samples for Marshall Test :
The wet process was used for the mixing of ingredients was done as per (STP 204-8).

A. First of all coarse aggregates, fine aggregates & fillers were taken in a pan.
B. The pan is than kept in an oven at 160°C for 2 hours. The aggregates & bitumen are needed to be mixed in heated state so preheating is required.
C. The bitumen is also heated up to melting point before mixing.
D. The aggregates also than heated in the pan over a stove for few minutes in order to maintain the above temperature.
E. The waste plastic is than mix in the bitumen by weight of bitumen according to the sample prepared and stir them well for two minutes.
F. Now, the aggregates and modified bitumen are put together and mixed. Mix them well for around 10-15 minutes until they mix up well to get a uniform color & texture.
G. The mix then compacted by the Marshall Hammer.
H. Total 150 blows were given to sample, 75 blows each side of the mould per sample.
I. Then these samples with moulds were kept separately and marked.

IV. RESULTS

Test Result On Bitume

BITUMEN 80/100 OR VG 10			
PROPERTIES	TEST METHOD	Results	Remark
PENETRATION (MM)	IS:1203-1978	9.1	Satisfactory
SPECIFIC GRAVITY	IS:1202-1978	1.01	Satisfactory
DUCTILITY(CM)	IS:1208-1978	89	Satisfactory
SOFTENING POINT (°C)	IS:1205-1978	53.7	Satisfactory

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Test Result On Aggregates

TEST	TEST METHOD	SPECIFICATION	RESULTS
Grain size analysis	IS:2386(Part I) [ISI 62]	Max 5% passing 0.075mm sieve	4.24%
Flakiness and Elongation indices (total)	IS:2386(Part I) [ISI 62]	30%(max)	27.64%
Water Absorption	IS:2386(Part III) [ISI 62]	2.0%(max)	1.16%
Crushing value	IS:2386(Part III) [ISI 62]	--	20.04%
Los Angeles Abrasion value	IS:2386(Part IV) [ISI 62]	35%(max)	18.40%
Impact Value	IS:2386(Part IV) [ISI 62]	27%(max)	19.01%
Soundness Test	IS:2386(Part V) [ISI 62]	12% (max)	10.5%

Data Calculated for Plotting Curves

Sample No.	W.P (%)	Bitumen content (%)	Mean Stability Value (kg)	Mean Flow Value (mm)	Mean Vv	Mean VFB	Mean Unit Wt
1	0	4.0	852	2.81	4.19	69.22	1.982
2	0	4.5	1052	3.31	3.72	72.98	2.009
3	0	5.0	719	3.82	3.56	74.56	2.001
4	8.0	4.0	1035	3.41	4.03	70.01	2.037
5	8.0	4.5	1156	3.59	3.49	74.65	2.043
6	8.0	5.0	1002	4.09	3.5	75.56	2.012
7	10	4.0	1035	3.78	4.52	65.75	1.966
8	10	4.5	1725	3.98	4.13	70.89	1.991
9	10	5.0	1160	4.75	4.02	72.58	1.984
10	12	4.0	1535	6.7	4.21	68.98	1.983
11	12	4.5	1978	7.35	3.74	72.84	1.995
12	12	5.0	1321	7.82	3.42	75.56	1.982

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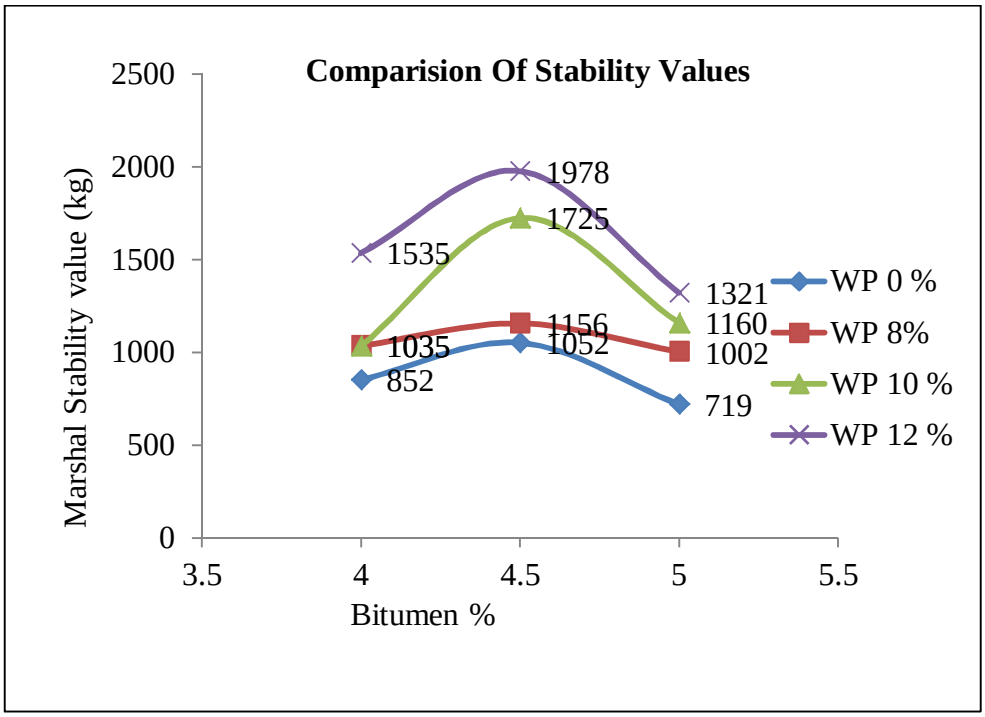
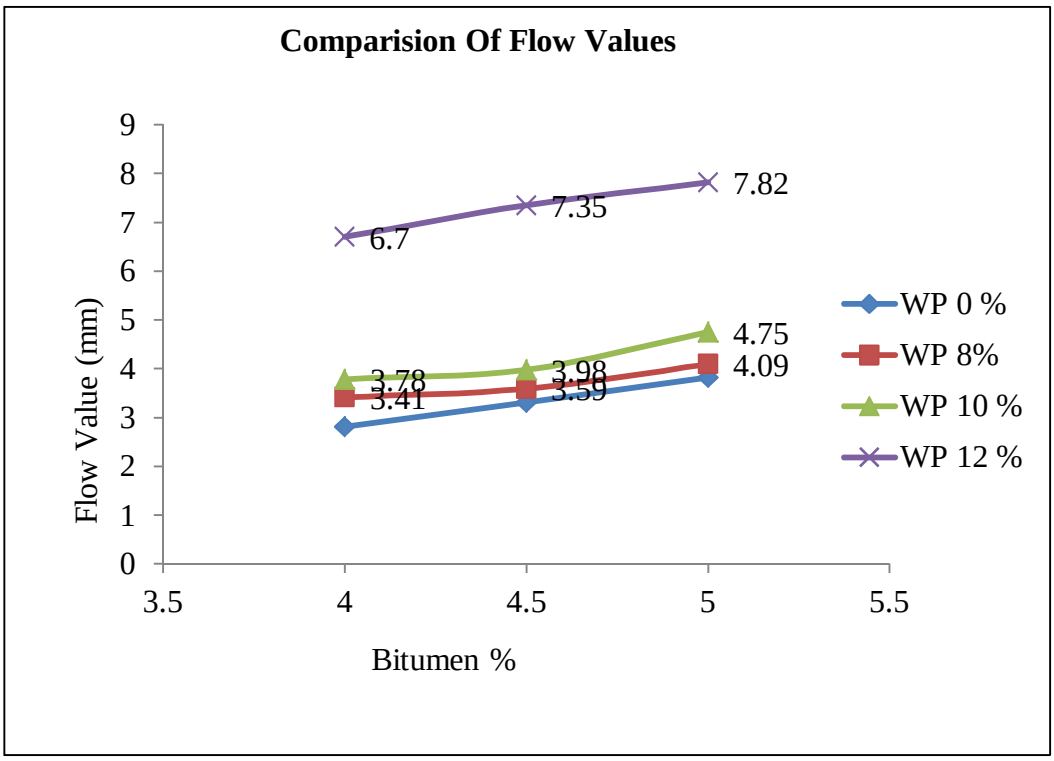
Comparison Graphs of Marshall Test Parameters





V. DISCUSSION

From the above comparison graphs we can see that the stability values keep on increasing after adding waste plastic at 12% but the flow values start increasing beyond the specified limits i.e. (2-4 mm) which is not acceptable so the bitumen content to be used for SDBC mix was found to be 4.5% and waste plastic to be used in between 8-10 %. The other parameters were within the MORTH specified limits.

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VI. CONCLUSION

This research studies the use of waste plastic to create modified Semi-Dense Bituminous Concrete for paving high strength roads for heavy traffic. For this waste plastic in different proportions was added in bitumen & samples were prepared and from the calculated results following conclusions were drawn:

A. It was observed that modified SDBC mix gives improved results of Marshall Characteristics than conventional SDBC mix.
B. It is observed that the Marshall Stability values increases with the increase in waste plastic for the aggregates and bitumen used.
C. The optimum bitumen content of the bitumen used was found to be 4.5% at which samples get the high stability values.
D. At 4.5% of bitumen content and 0%, 8%, 10% & 12% of waste plastic stability values were 1052 kg, 1156 kg, 1725 kg & 1978 kg respectively, but the flow values were found to be within permissible limits as specified by MORTH up to 10% addition of waste plastic
E. The other parameters of Marshall Test like Vv, VFB & Unit weight were under specified limits of MORTH for SDBC.
F. The stability value was kept on increasing even after the addition of 12% of waste plastic and the flow value too which shows waste plastic increase the melting point of bitumen and will results in rutting, potholes & disintegration of roads.
G. The optimum waste plastic content to be used in modified SDBC mixes should be 8% to 10%.
H. This study has an affirmative impact on the environment as it not only helps in reducing plastic waste but also gives us high strength roads with long life.

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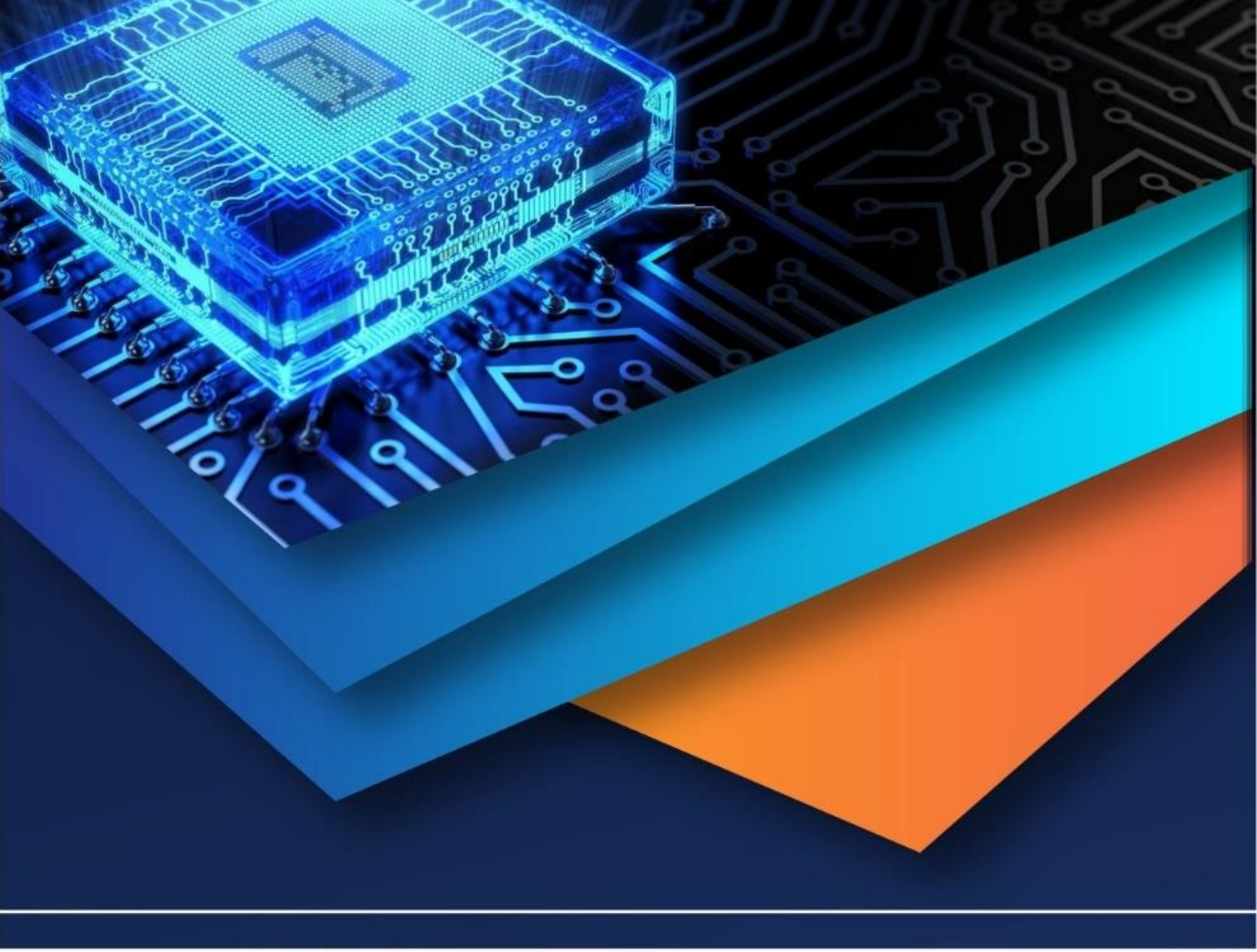

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