Experimental Investigation on Strength Properties of Modified Bitumen Using LDPE

Mohd Kaleem[1], Pratiksha Malviya[2]

[1]*M. Tech. Scholar,* [2]*Professor Department of Civil Engineering*

Millennium Institute of Technology, Bhopal, India

Abstract-LDPE (Low density Poly-ethylene), in bitumen and bitumen mixes for DBC (Dens Bituminous Concrete). Modification of bitumen by the addition of polymers can lead to significant changes in the mechanical properties of the bitumen. To utilize the non- biodegradable material which is otherwise a threat to the environment, in highway bituminous mixes substantially improving the stability or strength, fatigue life and other desirable properties of bituminous concrete mix, even under adverse water-logging conditions. Therefore the life of the pavement surfacing course using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen.

In India, bituminous surfaced flexible pavements comprise majority of the roads over rigid pavements. Distress symptoms, such as cracking, rutting and others. are being increasingly caused at earlier stages due to high traffic intensity, over loading of vehicles and significant variations in daily and seasonal temperature of the pavement. Investigations have revealed that modifiers can be used to improve properties of bitumen and bituminous mixes to make it more suitable for road construction. Bituminous-mix design involves mixing various sizes of aggregate and bitumen contents in optimum proportions. The modified bitumen shows better properties desired for road construction. The waste plastic bags for LDPE were heated to 160-180oC and added to the aggregate, for adding to bitumen (60/70) at 120-140oC. The LDPE-aggregate mix was then combined to get the sample for dense bituminous concrete (DBC).

In LDPE modified bitumen the higher marshal stability value is obtained when 8% LDPE is added to the mix.The Optimum binder content reduces in case of LDPE (5%) in comparison to ordinary bituminous mix (5.5%).In this study it was also observed that with the addition of modifier Percentage Air Voids were decreased but Flow Value & Voids filled with bitumen (VFB) are increased.The study indicate that use of LDPE as mix to bitumen gives sufficient strengths to the road surface, saves cost and economics use of bitumen.

Keywords: LDPE, DBC, Bitumen, Modifiers, Pavements, Durability, Marshal Stability.

I. INTRODUCTION

On the majority of roads, conventional bitumen performs satisfactorily. However, high traffic intensity, increasing axle load and daily and seasonal variations in temperature of the pavement lead to an early development of distress symptoms like raveling, rutting, undulations, cracking, bleeding, and potholing of bituminous surfaces. Thus the load bearing capacities of the road is to be increased. Flexible pavements (bitumen roads) comprise of the major portion of all surfaced roads. In India, it is estimated that over 33 lack kilometers of road exists and out of which of which around 50% is surfaced. Road transport has acquired dominant position amongst the various modes of transportation system due to its flexibility, door-to-door service, reliability and speed. In India, road transport carries close to 90% of passenger traffic and 70% of freight transport.

II. LITERATURE SURVEY

This chapter presents the characteristics of SMA with fibers to justify research aim and sets the background for the proposed work.

Vasudevan et. al. (2015), also observed that the polymer blended bitumen has better properties regarding Softening point, Penetration point, Ductility, Stripping Value and Marshall Stability value. Hence the blend can be used for laying flexible pavement. In this study both dry and wet processes were employed to prepare modified bituminous mixes. In the wet process, the blending was carried out by directly mixing the shredded polymer with hot bitumen at 160 deg. C. In the dry process, a novel technique was employed to use higher percentage of waste plastics in road construction and using this technique an alternate method was employed. In this method, the waste polymer was added on the hot aggregate (170deg.C). The polymer was coated over the aggregate. Here the spreading was easy. The hot aggregate was coated with polymer uniformly. Then the Bitumen was added. The mixing of bitumen with polymer was taking place at the surface of the aggregate. The temperature was around 155 –163 C. Both the polymer and bitumen were in the liquid state.

Vasudevan et. al. (2017), presented that plastic waste consisting of carry bags, cups and thermocoles can be used as a coating over aggregate and this coated stone can be used for road construction. By this process a road of 1 Km length and 3.375M width of single lane can consumes 10, 00000 carry bags and the road strength is increased by 100% and there is no pot hole formation. Penetration was reduced to a very low value and similarly the ductility. It

has been inferred that the use of higher percentage (more than 3%) of plastics in polymer modified bitumen is not favorable. The paper also studies use of crumb rubber waste as bitumen modifier. Waste tires are powdered and the powder is blended with bitumen (80/100) heated to 100-120oC and stirred at speed of 3000 rpm for 2-3 hours. This blend is used along with plastic coated aggregate. The mix polymer coated aggregate and tire modified bitumen have shown higher strength. The percentage of crumb rubber modifier in the mix varies from 1% to 5%.

III. OBJECTIVES

Feasibility of using LDPE and bitumen mixed for road construction.

To find out the strength of LDPE with bitumen roads as compare to DBM.

Methodology Adopted

Laboratory experiments were conducted on the conventional bitumen (60/70) and modified bitumen samples. Individual properties (Penetration, Softening Point, Ductility, Flash and Fire, and Specific Gravity) of the sample were determined. Using the Marshal Mix design characterization of conventional bituminous mix (60/70) for dense bituminous mix (DBC) were carried out and comparison was made for conventional bitumen mix properties with modified bitumen. After determining factors to be considered for modeling modified bitumen in bituminous mix, a detailed plan for the experimental program (sample preparation and lists of tests) was developed.

IV. RESULTS

Results of DBM with LDPE:

The results and analysis for ordinary bitumen mix shows that optimum binder content for the mix is 5.5% of the total weight of the aggregate. By using this optimum binder content i.e. 5.5% various samples of varying LDPE percentages (2%, 4%, 6%, and 8%) were prepared and subsequent test have been performed to find properties of modified dense bitumen mix. The table (4.5) shows various properties of LDPE modified DBM.

The results show that increase in percentage of LDPE in mix increases marshal stability value, bulk density and voids filled with bitumen (VFB) but decreases air voids.

It has been observed that modified mix shows better properties at 8% LDPE. Now the test were performed to find the optimum binder content with 8% LDPE modified mix. The results obtained are given below in table (4.6).

Table 4.5: Properties of DBM with LDPE Modified bitumen when using optimum binder content (5.5%)

S.No	*LDPE %*	*Weight of sample (gm)*		*Marshal stability (Kg)*	*Flow value (mm)*	*Bulk Density (gm/cc)*	*Air Voids %*	*VMA %*	*VFB %*
		Air	*Water*						
1	2%	1195	690	1297	2.45	2.367	3.97	13.38	70.34
2	4%	1188	688	1345	2.57	2.376	3.85	14.60	73.63
3	6%	1186	687	1382	2.63	2.378	3.79	15.26	75.17
4	8%	1197	696	1409	2.76	2.389	3.72	16.05	76.23

It is therefore inferred that 8% LDPE admixture saves bitumen content, without adversely affecting Marshal Stability Value.

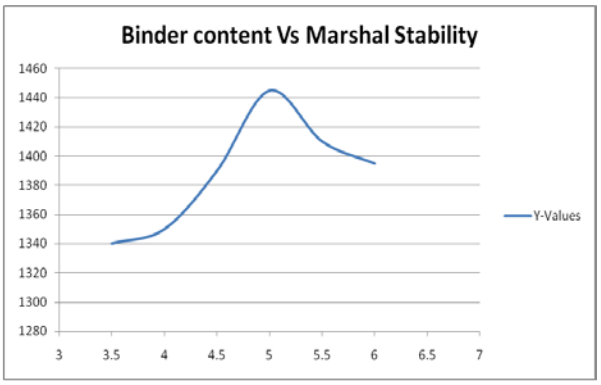

Figure 1: Bitumen % Vs Marshal Stability Value

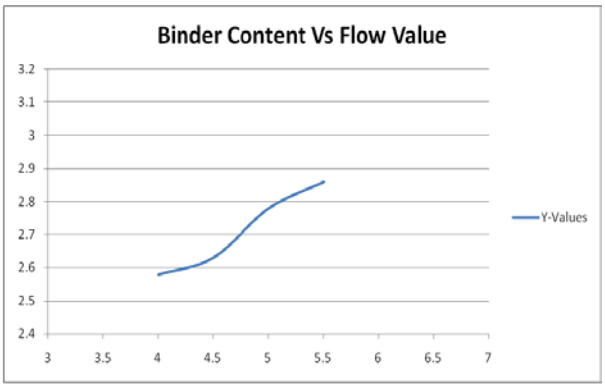

Figure 2: Bitumen % Vs Flow value

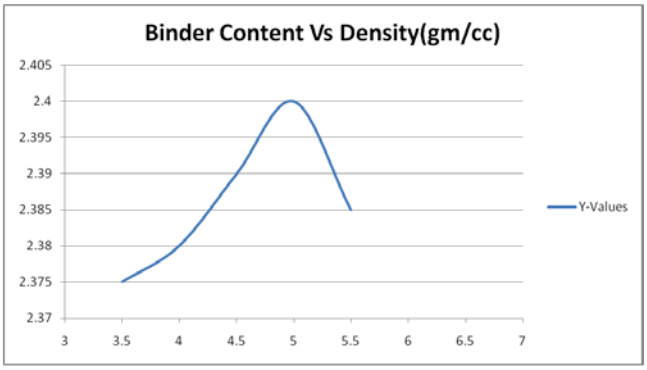

Figure 3: Bitumen % Vs Density

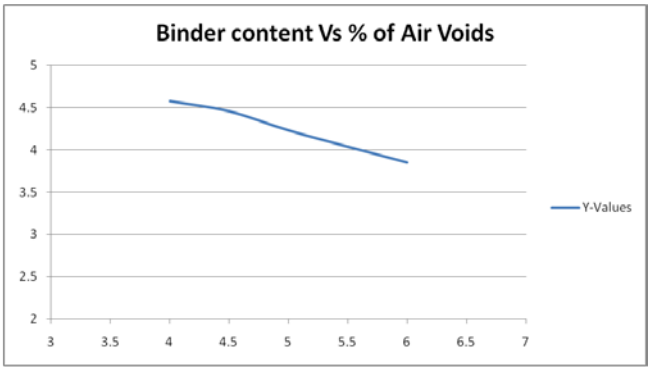

Figure 4: Bitumen % Vs Air voids %

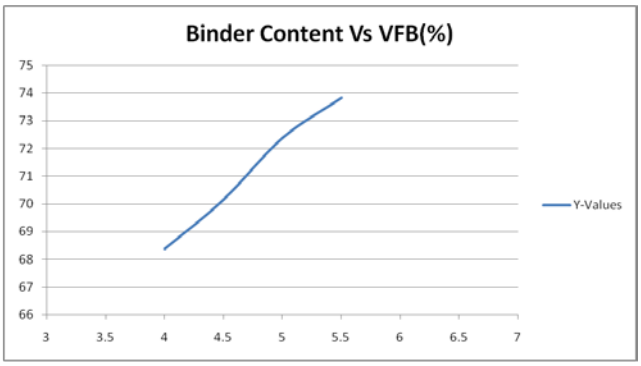

Figure 5: Bitumen % Vs Voids filled with bitumen %(VFB)

V. CONCLUSION

Based on this study the following conclusions are arrived:

Marshal Stability values and flow value of Dense Bituminous Mix (DBM) increase due to addition of LDPE.

In LDPE modified bitumen the highest Marshal Stability value is obtained when 8% LDPE is added to the mix. .

Use of LDPE shows even better Marshal Stability value (1409 kg) over ordinary bituminous mix (1183 kg).

Optimum binder content reduces in case of LDPE (5%) in comparison to ordinary bituminous mix (5.5%).

Marshall's mix design conducted on DBM using LDPE results as per MORTH recommendations, indicate the acceptability of the LDPE in Bituminous Concrete mix, since in acceptable range.

REFERENCES

[1] Aslam Shahan-ur-Rahman "Use of Waste Plastic in Construction of Flexible Pavement", New Building Materials & Construction World 2009.

[2] Chandra, R. and Rutsgi, R. (1997). "Biodegradation of Maleated Linear Low Density Polyethylene and Starch Blends." Polymer Degradation and Stabilization. 56. 185-202

[3] Food Science and Technology, 14, 71–78

[4] Gopalakrishnan K.S. "An Insight into Rubberized Roads, Indian Road Congress Seminar on Bituminous Roads" Design and Construction Aspects 1994.III. Effect of Amylopectin to Amylase Ratio in Starch. European Polymer Journal. 34(10): 1467- 1475.

[5] IRC: SP: 53 "Guidelines on the use of polymer and rubber modified bitumen in road construction." Indian Road Congress, New Delhi 2002.

[6] Justo C.E.G. , Veeraragavan A "Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads", Centre for Transportation Engineering, Bangalore University, Bangalore, India, April 2002.

[7] Khan Amjad, Gangadhar, Murali Mohan, Raykar Vinay, "Effective Utilisation of Waste Plastics in Asphalting of Roads". R.V. College of Engineering, Bangalore 1999.

[8] Khanna S.K.,Justo C.E.G,A Text Book of Highway Engineering,Nem Chand Publication New Delhi 2001.

[9] LEBBAI SHEIKNA ,S.V. SIVAPRAKASH S. Road Construction With Plastic Wastes National Conference on Recent Trends in Engineering Sciences 2011.

[10] Mali, S., & Grossmann, M. V. E. (2003). Effects of yam starch films on storability and quality of fresh strawberries. Journal of Agricultural and Food Chemistry, 7005–7011.