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Performance Evaluation of Different Grades of Polymer Modified Bitumen in Stone Mastic Asphalt

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Abstract - In the present investigation SMA samples are prepared by adding Polymer Modified Bitumen, i.e. PMB 40 and PMB 70. This study was done to find the improvement in the properties of SMA due to addition of modified bitumen. This examination was done to discover which review of bitumen is most appropriate for stone grid black-top mix. Marshall Samples were prepared using SMA mixes with different binders, varying the binder content. Two types ofbinders, PMB 40 and PMB 70 binder were used in varying proportions 5-7% (5, 5.5, 6, 6.5 and 7%) to make a comparative study. The results show that addition of PMB improves the volumetric properties of SMA.

Key Words: Stone Matrix Asphalt, Polymer modified bitumen, Marshall Stability, Binder draindown, Tensile Strength

1. INTRODUCTION

Transport plays an important role in the economic development of any region. Economic growth that result in higher incomes and a rising living standards are expected to create greater demands for travel for both work and non-work/leisure purposes. This is turn can create congestion and reliability problems on the transport network, increasing costs on business and damaging quality of life. As road transport provides door-to-door connection and flexible movement of goods and passengers, itspatronage by people are on the rise day by day. The quality of life now greatly depends on the quality of roads. **(Draft Transport Policy Report 2011, NATPAC)**

1.1 Stone Matrix Asphalt

Stone Matrix Asphalt (SMA) is one of the new generation mix within the country. SMA, an asphalt paving mixture, was originated in Germany in the 1970's to provide maximum resistance to rutting caused by the studded tyres on European roads. SMA is characterized by its high stone content which forms a gap-graded skeleton-like stone structure. It is a material with a high mineral aggregate (stone) content generally in the range of 70-80% coarse aggregate. The remaining percentage of material is a combination of Crushed Rock Fines (CRF), filler (material passing the 75 micron sieve) and bitumen resulting in a material with approximately 4% voids. The bitumen shall be viscosity grade VG-30 complying with Indian Standard Specification for paving bitumen IS 73 or modified bitumen (MB) of appropriate grade complying with IS 15462.

1.2 Modified Bitumen

Bitumen is the residue product from the distillation of crude oil. They are used primarily for their waterproofing properties in the construction industry and their binding properties in the road industry. Bitumen is a thermoplastic material and has important limitations due to their temperature sensitivity. It also helps to improve the strength of the road. But its resistance towards water is poor. Anti stripping agents are being used. Use of the anti stripping agents depends on the type of bitumen and the environmental conditions.

Table -1: Types of Additives for Bitumen Modification and their Indicative Doses (IRC: SP: 53-2002)

S.no	Types Of Modifier	Example	Indicative Level
1	Plastics Thermoplastics Thermosets	Polyethylene Ethylene vinylacetate Epoxy resin	 3-6 3-5
2	Elastomers Natural Rubber Synthetic Elastomers	Dry rubber content Styrene Butadiene copolymer	2-4 3-5
3	Reclaimed Rubbers	Crumb Rubber Powder further improved by additives	10-12

1.2 Polymer Modified Bitumen (PMB)

Polymer Modified Binders (PMB's) are chosen as a means of reducing binder drainage without the need for fibres. In hot climates, PMB's are considered to provide additional resistance to bleeding, taking out some of the risk associated with high binder contents and narrow margin for error in overfilling of voids with binder (**Stuart and Malmquist (1994), Sikdar and Jain (1999), Salter (1987), Shukla and Jain (1984)**) have showed that the properties of bitumen can be improved by incorporation of additives or

blend of additives such as sulphur, polymers, rubber etc. Polymer modification also significantly improves the temperature susceptibility of bitumen's

Applications of rubber and polymer modified bitumen are listed below:

1.High Stiffness Modulus

2.Enhanced Fatigue Life

3.Better Resistance to Creep

4.High Indirect Tensile Strength

5.Quite Suitable as Renewal Course and Overlay Material

6.Used as Stress Absorbing Membrane (SAM) for Sealing of Cracks

7.Used as Interim Overlay for Preventive Maintenance

8.Stress Absorbing Membrane Interlayer to delay Reflection Cracking (**New AndInnovative Materials For Long Lasting Road Infrastructure)**

Effect of Adding Polymers on Binder Properties

1.Increased in softening point and decrease in brittleness (Plasticity interval isincreased).

2.Ensures more protection against hot climate conditions and less susceptibility totemperature variation.

3.Increased in elastic recovery, which ensures more resistance to cold climaticconditions and crack resistance.

4.Better adhesion of the binder to the aggregate, which ensures longer life, strengthand stability of road.

5.Improvement in ageing characteristics for longer life of road.

6.Reduces drain drown in an uncompacted bituminous mixture.

2. Objective

The primary objective is to evaluate the engineering properties of Polymer Modified Bitumenand for its potential application in wearing courses like SMA. The objective of the present investigation is given below:

1. To evaluate the Performance of Polymer Modified Bitumen formulations by testing Various Physical & Engineering properties.

2. Comparative study of all characteristics of Stone Matrix Asphalt (SMA) mixes, using PMB 40 and PMB 70.

3. To characterize the SMA mixes for different laboratory compaction efforts using thestandard Marshall Compaction (MC) method.

4. To evaluate the stability, flow value and volumetric properties of Stone MatrixAsphalt (SMA) mixes by Marshall Method of mix design.

5. To study the indirect tensile strength, rut depth and moisture susceptibility characteristics of Stone Matrix Asphalt (SMA) mixes.

6. To study the performance of Stone Matrix Asphalt (SMA) mixes under repeatedloads.

3. RESULT

In this study, three types of binders, namely VG 30, PMB 70 and PMB 40 grade binders havebeen used in the SMA mixes. The details of the experiments carried out on SMA mixes were given in the previous chapter. In this chapter the results and observations of the tests conducted are presented, analyzed and discussed.

Binder Draindown Test

Table 4.1 Draindown values of SMA mixes

Type of Bitumen	Draindown (%)
VG 30	0.390
PMB 70	0.002
PMB 40	0.000

Boiling Test

Table 4.7 Stripping Value of SMA mixes

Type of Bitumen	Per cent Stripping	As per MORT&H(2004)
PMB 70	0	Stripping value should not be morethan 10 per cent.
PMB 40	0	

Rutting Test

Table 4.8 Deformation of SMA Slabs in Rutting Test

S.No.	Number of Passes	Deformation (mm)	
		PMB 70	PMB 40
1	0	0.0	0.0
2	1000	0.4	0.6
3	2000	0.6	0.8

4	3000	0.6	1.0
5	4000	0.7	1.1
6	5000	0.7	1.2
7	6000	0.8	1.3
8	7000	0.9	1.4
9	8000	1.1	1.6

4. CONCLUSIONS

1. Addition of PMB improves the volumetric properties of SMA. The OBC at 4% air voids was found to be 6.4% and 6.3% for PMB 70 and PMB 40 respectively. The Marshall Stability value at OBC for SMA mix prepared with PMB 70 was found to be3.05% more than that of SMA mix prepared with PMB 40.

2. PMB 40 and PMB 70 binder showed very negligible draindown values. This indicatesthat separation of fines and bitumen noticed during transportation and placing of the mixture is restricted to a large extent.

3. The Tensile Strength Ratio was found to be more than 85%. This shows that addition of PMB increases the moisture resistivity of the SMA Mix, which is due to thecoating of PMB to the aggregates

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