AN EXPERIMENTAL STUDY ON WARM MIXES USING VG-40 AND CRMB ON BITUMINOUS CONCRETE

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Abstract- *The present study was carried out to observe the effect of mixing of warm mix chemicals on some of the properties of Bituminous Mixes. Further, the cost benefit analysis was also carried out to check the economical viability by using sasobit vis-å-vis zeolite, their combination and with different grades of pavement mixes. Desired viscosity to fully coat aggregates is obtained by adding certain chemicals these chemicals can either be in powder form or in liquid form. With the reduction in production temperature there are some additional benefits, such as reduced greenhouse gas emissions, fumes, and odors generated at the plant and the paving site. From the results of present study, it can be concluded that in spite of being expensive WMA have good performances than HMA.*

Keywords: *Bitumen, Bituminous Concrete, Warm Mix Asphalt, Hot Mix Asphalt.*

1. Introduction

Bitumen is the oldest known engineering material and has been used from the earliest times as an adhesive, sealant and waterproofing agent. As long ago as 6000 BC the thriving ship-building industry in Sumeria used naturally occurring bitumen, found in surface seepage in the area.

CRMB is produced by the so-called wet process in which crumb rubber is added to hot bitumen and the mixture is agitated mechanically until there is a "reaction" between the bitumen and crumb rubber. Improved adhesion and bonding with aggregates, higher softening point, high flow resistance and higher impact resistance, takes heavy vehicular traffic etc.

Polymer modified bitumen (PMB) with elastomers is most commonly used with success on major highways in the developed countries because elasticity in this PMB provides resistance to both rutting and fatigue cracking. Used for much stressed pavements, high traffic volumes, high loading, and high temperature amplitudes, draining pavements etc.

Due to less greenhouse gas emissions, fumes/odors and energy conservation are making WMA preferred due to its reduced asphalt mix production and placement temperatures. The paving industry is continuously in search of technological improvements that will enhance the material's performance, increase construction efficiency conserve resources, and advance environmental benefits. Warm mix asphalt is developed at a temperature lower than typical hot mix asphalt (HMA) 20 - 40 degree Celsius. WMA is famous worldwide to decrease the bituminous mixing temperature compromising its strength. There are some additional advantages that are reduced greenhouse gas emissions, fumes, and odors generated at the plant and the paving site etc.

2. Objectives of the Study

The objectives of this study are to include the following aspects:-

1. To compare the various properties of normal vs. warm mix asphalt by Marshall Method

- Marshall stability
- Flow value
- Density
- VMA (Voids in Mineral Aggregates)

- VFB (Voids Filled with Bitumen)
- Vb(Volume of Bitumen)
- Va (Volume of Aggregates)

2. To ascertain the effect of changing grade of binder, VG-40. CRMB.

3. The effect of any change in Optimum Binder Content due to usage of warm mixes

4. To make a Cost comparison between Hot mix and Warm mix.

3. Methodology

In order to achieve the proposed objective the following methodology will be adopted:

1. Prepare the samples of Bituminous Concrete (BC) using VG-40, CRMB 55 from Marshall Method for normal mixes.
2. For Normal Mixes:
   - For BC we need to find out optimum binder content by Marshall Stability Method using VG-40, CRMB 55.
   - Find VMA, VFB, Air void, Stability, Flow value
3. For Warm-Mixes:
   - Find out the Optimum Binder Content using Zeolite by Marshall Stability method with VG-40, CRMB 55.

According job mix formula quantity of aggregates used are as follows-

- 20 mm = 10% of 1200g= 120g
- 10 mm = 26% of 1200g=312g
- 6.7 mm = 45% of 1200g= 192g
- Stone dust = 16% of 1200g = 540g
- Cement = 3% of 1200g =36g

4. Results and Discussion

Table1. Test Results of Marshall Stability for CRMB-55: Normal Mix.

Bitumen%	5.5118	5.66	5.808	5.956
Density, g/cc	2.348	2.351	2.346	2.331
Volume of bitumen, Vb%	12.941	13.289	13.625	13.889
Volume of aggregates Va%	81.23	81.05	80.7065	80.035
Voids in mineral aggregate (VMA)%	17.221	17.251	17.556	18.232
Void filled with bitumen (VFB)%	75.14	77.033	77.608	76.146
Stability,(KN)	13.88	13.96	18.01	15.53
Flow value, mm	3.7	4.2	4.25	4.35

Table: 2. Test results of Marshall Stability For CRMB-55: Warm Mix

Bitumen %	5.5118	5.66	5.808	5.956
Density,g/cc	2.3305	2.344	2.342	2325
Volume of Bitumen, Vb%	12.854	13.267	13.602	13 .847
Volume of aggregates, Va%	80.63	80.808	80.568	79.829
Voids in mineral aggregate (VMA)%	17.844	17.507	17.697	18.437
Voids filled with bitumen(VFB) %	72.035	75.78	76.89	75.104
Stability,(KN)	14.56	15.44	21.35	2123
Flow value ,mm	4.05	4.2	4.4	4.55
Marshall Quotient (stability//flow)	3.59	3.67	4.85	4.66

Table: 3. Test Results of Marshall Stability For VG 40 Normal Mix

Bitumen %	5.5118	5.66	5.808	5.956
Density,g/cc	2.3465	2,358	2.343	2.34
Volume of Bitumen, Vb%	13.032	13.459	13.068	13.937
Volume of aggregates, Va%	81.096	81.306	80.62	80.34
Voids in mineral aggregate (VMA)%	17.25	17.01	17.54	17.76
Voids filled with bitumen(VFB) %	75.53	79.07	77.58	78.49
Stability,(KN)	15.18	15.18	18.35	18.28
Flow value ,mm	4	4.6	4.7	4.8
Marshall Quotient (stability//flow)	3.75	3.3	3.90	3.80

Table: 4. Test results of Marshall Stability for VG 40 Warm Mix

Bitumen %	5.5118	5.66	5.808	5.956
Density,g/cc	2.36	2.3485	2.337	2.33
Volume of Bitumen, Vb%	12.875	13.292	13.573	13.877
Volume of aggregates, Va%	80.73	80.97	80.41	80.00
Voids in mineral aggregate (VMA)%	17.525	17.042	17.755	18.11
Voids filled with bitumen(VFB) %	73.466	78.004	76.44	76.26
Stability,(KN)	15.08	15.88	21.86	21.00
Flow value ,mm	3.9	4.075	4.45	4.95
Marshall Quotient (stability//flow)	3.87	3.89	4.91	4.24

For cost comparison analysis i have gathered data from different hot mix plants:

Fuel Used For Heating Material in One Day For 110t Mix = 5.5 To 6 Liters/Ton

Material Prepared In One Day = 200 Ton

Cost Of Fuel Used (Furnace Oil) = 43 Rs/ Liter

Therefore Fuel Used In One Day = 1200 Liters

Total Cost Of One Day Fuel = 1200 X 43 = Rs. 51600/-

As Per Our Study Fuel Used For Warm Mix = 4.5 Liters/ Day

Therefore Fuel Saving In One Day = 1.5 Liters/ Ton= 1.5 200 = 300 Liters

Total Money Saving In One Day = 300 X 43 —Rs 12900/-

For 5.66% of Bitumen

Bitumen Used In One Day (For 200 Ton Material/ Day) = 11.32 Ton i.e. 11320 Kg

Warm Mix Chemical Used In One Day (1% Of The Bitumen) = 113.2 Kg

Cost Of 100 Gm Warm Mix Chemical = Rs 6,500/-

Cost Of 1 Kg Warm Mix Chemical = Rs 25,000/-

Therefore Cost Of 113.2 Kg Warm Mix Asphalt =Rs 28,30,000/-

From this calculation we have seen that the warm mix chemical is not cost effective at all. The reason of this may be non-availability of this chemical in India. If cheaper alternative is available then it can be tried and tested.

5. Conclusions

Following are the outcomes of the experiment conducted for comparison of WMA mixes and HMA mixes:

1. Density: of Warm Mix Asphalt samples is lower as compared to Hot Mix Asphalt.
2. O.B.C: optimum binder content for Normal Mixes is found out to be 5.75 by comparing certain specifications from MORTH 5 th revision it is found out that Optimum Binder Content for Warm Mixes is same as that of Normal samples. It clearly indicates that there is no change in Optimum Binder Content for Warm Mixes.
3. Marshall Stability: There is a considerable increase in Marshall Stability value of Warm Mix as compared to Hot Mix Asphalt. It concludes that Warm Mix sample have higher strength than Hot Mix samples.
4. Percent VFB: it was found to be decrease in warm mixes as compared to hot mixes
5. Percent VMA: (Voids in Mineral Aggregates) were found to be increased in warm mixes than hot mixes.
6. Va and Vb were found to be decreased in warm mixes when compared to hot mixes. Time of mixing in warm mixes is approximately 5-6 min which is less than hot mixes that is found to be 8-10 min in laboratory conditions resulting in fuel saving.

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