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BITUMEN MIX WITH EMULSION ADDITIVE IN WARM MIX ASPHALT

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Abstract

Warm Mix Asphalt (WMA) innovation is as of late created in Europe and is increasing solid intrigue around the world. By bringing down the consistency of bitumen folio, WMA innovation permits mixing, transporting and gives better workability at lower temperature. Utilizing WMA innovation, asphalt mix can be created which is 30°C to 40°C lower than hot mix asphalt (HMA). Less discharge, funds in vitality cost, less smell are there a direct result of lower mixing and compaction temperature. Notwithstanding the advantages, looks into are there to examine its long haul execution.

This venture was completed to assess the appropriateness of bitumen emulsion as an added substance when connected to WMA tests of Stone Matrix Asphalt (SMA) and Dense Bituminous Macadam (DBM) mix according to MORTH determination. The fastener content has been fluctuated from 4 % to 7 % by weight of totals for both mixes. Concrete and stone clean have been utilized as filler for DBM and SMA mixes individually. VG 30 review bitumen has been utilized as folio for both mixes. The ideal folio content for SMA and DBM mixes were observed to be 5.93% and 5.33%.

Key Words: Stone Matrix Asphalt (SMA), Dense Bituminous Macadam (DBM), Emulsion(CMS), Marshall Properties..

1. INTRODUCTION

1.1 INTRODUCTION

The concept of using lower temperatures to produce asphalt mixes dates back to the1950s (Vaitkus et al. 2009). The modern WMA was born in Germany in the mid-1990s

with the use of waxes as viscosity modifiers for mastic asphalt. Since then a variety of new technologies has been developed in Europe and in 2002 WMA was introduced in the US (D'Angelo et al. 2008). During the last decade the US has become the world leader in implementing WMA technologies (EAPA 2013). Here since 2009 the WMA use has increased by 416 % and in 2012 78.7 million tonnesor 26 % of asphalt mixtures were produced by applying one of the warm mix asphalt technologies (Hansen and Copeland 2013). There are many reasons for such advance, the most important of which are reduced energy consumption, limited emissions, and, perhaps most importantly, improvement in asphalt workability at similar or even lower temperatures compared to HMA.

In Europe the use of WMA has not become as widespread as in the US and currently only a small portion of asphalt pavements is produced as WMA (EAPA2012). European countries use WMA more as a niche product for special applications rather than a replacement for conventional HMA. The specific applications often include projects that require improved workability, fast opening times (airfields, night work, junctions), and environmentally critical areas.

The different products fall into one or more of the three general WMA production Techniques:

- Foaming technologies, including mechanical foaming and water bearing minerals.
- Organic or wax technologies.
- Chemical additives.

Some of these technologies involve permanent or temporary altering of the binder properties, such as reducing the viscosity. Others rely on improving the coating of aggregates by chemically improving the adhesion between binder and aggregates or introducing surface active agents to improve the aggregate wet ability. In the US foaming technologies with the use of nozzles are the most popular among the WMA products accounting for 88 % of the market (Hansen and Copeland 2013). This is likely due to their satisfactory performance and the lowest costs among WMA technologies.

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2 LITURATURE REVIEW

Zycotherm 3C Nanotechnology report recommends dosage from 0.1 to 0.15% by weight of bitumen. Zycotherm create a hydrophobic zone over aggregate surface and therefore work as water repellent and improves potential against moisture induced damage. Prajapati et al. (2015) studied the property of CRMB 60 with Zycotherm WMA.

Hurley and Prowell (2006) reported that, the low compaction temperature used while producing Warm Asphalt with the addition of Aspha-min may increase the potential for moisture damage. Low mixing and compaction temperatures can result in incomplete drying of the aggregate and the water trapped in the coated aggregate may cause moisture damage.

Hodo, Kvasnak, and Brown (2009) stated that the foamed asphalt mixtures presented better workability at lower temperatures which showed greater ease in placing and compacting it. The moisture susceptibility tests showed marginal results and they suggested that if anti-stripping agents were added to the WMA mixture, the moisture damage resistance would be improved.

3. EXPERIMENTAL INVESTIGATION

3.1 Materials Used

3.1.1 Coarse and Fine Aggregate

According to BIS 383:1963 aggregates which are retained on 4.75 mm BIS Sieve is defined as coarse aggregate and which will pass through 4.75 mm BIS Sieve is defined as fine aggregate. The Ministry of Road Transport and Highways (MORTH) recommended gradation as per nominal maximum size of aggregate (NMSA) 19 mm for DBM and 13mm for SMA shown in Table 3.1

Table 3.1 Gradation for DBM (MORTH)

BIS Sieve	% passing (range)	% passing (adopted)
26.5	100	100

19	90-100	95
13.2	56-88	72
4.75	16-36	26
2.36	4-19	11.5
0.3	2-10	6
0.075	0-8	4
Bitumen content (%)	4-7	4-7

Table 3.2: Gradation for SMA (MORTH)

BIS Sieve	**% passing (range)**	**% passing (adopted)**
26.5	-	-
19	100	100
13.2	90-100	95
9.5	50-75	62.5
4.75	20-28	24
2.36	16-24	20
1.18	13-21	17
0.6	12-18	15
0.3	10-20	15
0.075	8-12	10
Binder Content (%)	5-7	5-7

Table 3.3: Laboratory test result of aggregate

Test of Aggregates	Laboratory Results
Impact Value (BIS 2386-Part IV)	14.73 %
crushing value(BIS 2386-Part IV)	14.69%
Los Angel's Abrasion Value (BIS 2386-Part IV)	15.86%
Specific Gravity (BIS 2386- Part III)	2.8
Flakiness (BIS 2386-part IV)	18.88%
Elongation Index (IS 2386-part IV)	21.64%

3.1.2 Binder

Bitumen is a non-crystalline viscous material black/ dark brown in colour, which is substantially soluble in carbon disulphide (CS2), having adhesive and water-proofing qualities. It consists of hydrocarbons having 80% carbon and 15% hydrogen, the rest 5 % is oxygen, sulphur and nitrogen. Bitumen acts as a binder in SMA and DBM mix. In the study preparation of SMA and DBM mix VG 30 bitumen used as binder. Penetration Test determines the hardness of Bitumen by measuring the depth.

3.1.3 Emulsion (CMS)

In the experiment Cationic medium setting (CMS) emulsion is used. Cationic defines that the particles of the emulsions are contains positive charge. Here the break is sufficiently slow so that the emulsion can be mixed with aggregate containing a high proportion of fine materials.

3.1.4 Filler

Filler fills the voids between aggregate grains and improves the wearing capabilities of mix. It is stored and fed dry into the mix, during or after addition of binder. Stone dust, slag dust, hydrated lime, fly ash, mineral filler and cement are used as filler. Also fine aggregate below 75micron can be used as filler. For this observation stone dust and cement have been used as filler for SMA and DBM composition respectively. The filler also improve the binding property between the aggregate.

3.2 Preparation of Sample

3.2.1 Sieve analysis

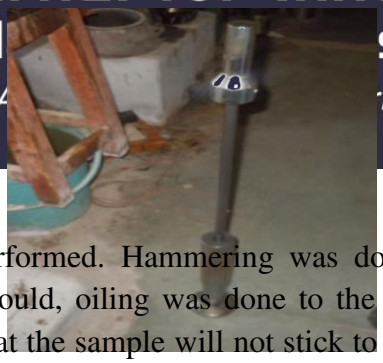
Sieve analysis was done by BIS sieve size of 19mm, 13.2mm, 9.5mm, 4.75mm, 2.36mm, 1.18mm, 0.6mm, 0.3mm and 0.075mm and aggregates were collected and stored. Total weight of one sample is 1200 gms.The distribution of aggregates was taken as per Table3.2 for SMA composition and Table 3.1 for DBM composition. The samples have been prepared by following steps.

3.2.2 Mixing of components

Aggregate, bitumen, emulsion and stone dust (in SMA) were mixed to make a homogeneous SMA Mix and in DBM composition we use cement instead of stone dust as filler. After mixing of dry samples with required quantity of binder and emulsion, the mixture was put in to the Marshall moulds diameter in 100 mm. Mould was heated and coated with oil before use so that mixture may not be cold before hammering.

Figure3.1 Mixing of component

3.2.3 Compaction



After putting in mould, hammering was performed. Hammering was done with a standard hammer. Before putting the sample into mould, oiling was done to the bottom of hammer and also to the inner face of the mould so that the sample will not stick to the mould and hammer. Then a piece of paper of diameter equal to the mould was put over fitting. Then 75 blows to each side of the specimen were given for compaction purpose.

Figure 3.2 Specimen mould holder

Figure 3.3 Hammer used for compaction

3.2.4 Finalizing the sample

The sample was taken out of mould after hammering. To recognize it later, name sticks representing sample's binder content, sample number, and type of additives used are glued to sample for example: S1-5%-EMULSION. Then the sample was left to cool down to room temperature.

Figure 3.4 Extraction of sample from mould

Figure 3.5 Prepared Sample

3.3 Experiments Performed

When the samples were prepared they were supposed to go under Marshall Test which was performed as per ASTM D 6927 – 06. This test gives the flow value and stability number of different samples. But before Marshall Test, the samples had to go through certain procedures.

First dry weight of samples are taken and recorded. Weights of samples in water are also needed. So paraffin was heated up to liquefaction and sample is immersed in paraffin by holding it through a thread. Then the sample was allowed to cool so that sample is coated with

paraffin. This was done because sample has voids so water may enter in voids. After paraffin coating the weight of sample is taken. Now weight of sample in water is recorded.

After weighing, the sample is put in water bath before testing up to a maximum of 30 minutes. In water bath temperature of 60°C is maintained throughout. After 30 minutes, the samples are ready for Marshall Test.

Figure 3.6 Water bath

3.3.1 Marshall Test

The Marshall test was conducted as per given in ASTM D 6927-06. Marshall Test Apparatus has following parts

3.3.2 Breaking Head

The breaking head consists of upper and lower cylindrical segments of cast iron. The lower segment was mounted on a base having two perpendicular guide rods or post extending upwards. Guide sleeves in the upper segment direct the two segments together on the guide rods.

Figure 3.7 Breaking Head of Marshall Apparatus

3.3.2.1 Load Measuring Device

A 25 KN capacity of proving ring was used for testing the specimens. The proving ring is equipped with a micrometer dial graduated in 0.0025 mm increments. The upper

portion of the ring is attached to the testing frame and the lower portion transmits the load to the breaking head.

Figure 3.8 Proving Ring

3.3.2.2 Flow value measurement

A dial gauge is used to measure the flow value. By dial gauge initial and final values is recorded

and their difference is taken as flow.

Figure 3.9 Flow Measurement in progress

3.4 Test procedure

- Immerse the specimens in a water bath at 60°C for 30. Thoroughly clean and lubricate the guide rods so that the upper test head slides freely over them.
- Remove the specimen from the water bath and place in the breaking head. The elapsed time between removal of the sample from the water bath and maximum load determination shall not exceed 30 sec.

- Place the complete breaking head assembly in position on the testing machine. Place the flow meters, and adjust it to zero.
- Apply the load to the specimen by a constant rate of movement of the testing machine head of 50 mm per minute until a maximum load is reached and the load decreases as indicated by the proving ring dial.
- Record the proving ring micrometer dial reading.
- The total maximum in kN (that causes failure of the specimen) is taken as Marshall Stability.

- The stability value obtained is corrected for volume by using correlation ratio table.
- The total amount of deformation in units of
- 0.25 mm that occurs at maximum load is recorded as Flow Value.

4. RESULT:

In this chapter the results and observations of the tests conducted are presented, analyzed and discussed.

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4.1 Test results of SMA

Table 4.1 Physical properties of SMA samples

Sampl	Temperature ( )	Bitumen (%)	Weight of sample	Weight of sample after paraffin coat	Weight of sample in water	Height (mm)	Radius (mm)	Weight of aggregate mix (gm)
1		5	1197	1211	717	61.5		1140
2			1194	1209	713	61.5		1140
3			1199	1213	715	62		1140
1		5.5	1196	1204	706	62		1134
2			1194	1202	703	61.5		1134
3			1197	1206	705	62		1134

1		6	1196	1215	710	62		1128
2			1192	1208	708	61		1128
3	110		1196	1214	709	61.5		1128
1		6.5	1187	1202	698	60.5	50	1122
2			1189	1205	705	62		1122
3			1194	1210	713	61		1122
1		7	1196	1217	712	60.5		1116
2			1192	1211	709	61.5		1116
3			1189	12	708	62		1116

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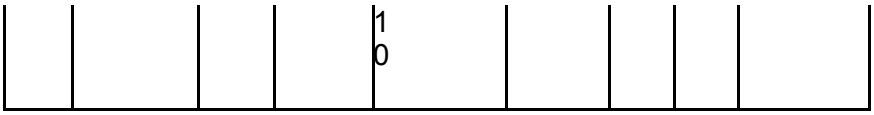

Relationships on SMA:

Binder content vs. stability

Table 4.2 Average stability and Bitumen content for SMA samples

Binder Content (%)	Stability (kN)
5	8.3
5.5	11.65
6	9.48
6.5	8.10
7	7.50

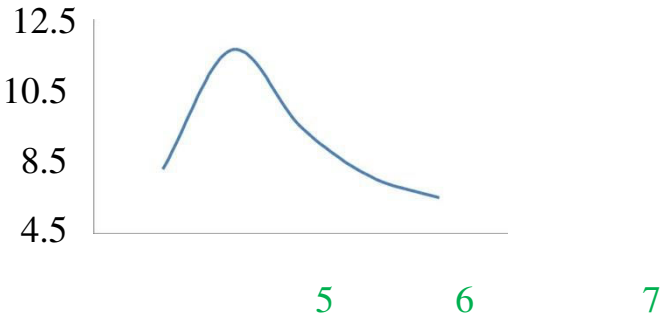

Figure 4.1: Plot between Stability and Binder Content

Binder content vs. Flow value

Table 4.3 Average flow value and Bitumen content for SMA samples

Binder content (%)	Flow value(mm)
5	2.3
5.5	2.38
6	2.533
6.5	2.92
7	4.2

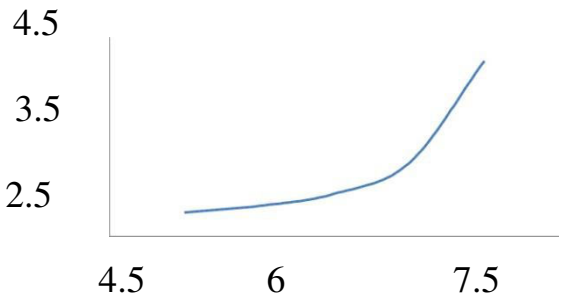

Figure 4.2: Plot between Binder content vs. flow value

Binder content vs. VMA

Table 4.4 Average VMA and Bitumen content for SMA samples

Binder content (%)	VMA (%)
5	17.104
5.5	16.02
6	15.5
6.5	15.65
7	16.12

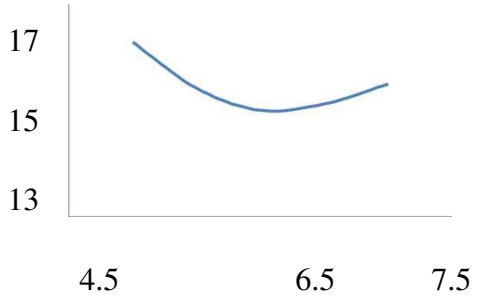

Figure 4.3: Plot between Binder content vs. VMA

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4.2 Test Results of DBM:

Table 4.5 Physical properties of DBM samples

Sampl	Temperature ( )	Bitumen (%)	Weight of Sample in air	Weight of sample after paraffin coat	Weight of sample in Water	Height (mm)	Radius (mm)	Weight of aggregate mix (gm)
1	110	4	1198	1209	706	62	50	1152
2			1195	1204	704	63		1152
3			1195	1205	707	61.5		1152
1		5	1192	1212	703	61.5		1140
2			1194	1213	703	61.5		1140
3			1195	1217	708	61		1140
1		6	1190	1210	706	62		1128
2			1193	1213	709	61.5		1128
3			1196	1214	709	60		1128
1		7	1199	1204	711	61		1116
2			1199	1205	706	62.5		1116
3			1195	1202	703	61.5		1116

5. CONCLUSION

In this observation, two types of mixes i.e. SMA and DBM specimens were prepared using VG 30 as binder tested on Marshall Test Apparatus. By Marshall Method of mix design, the optimum binder contents for both the mixes were found 5.93% and 5.33% for SMA and DBM respectively. When using Cationic Medium Setting type emulsion with binder, the properties of Mix was improved. Maximum stability value was observed for SMA 11.65 KN and 13.28 KN for DBM mixes. Flow value of SMA and DBM samples gradually increases with increase in bitumen content. VA of Marshall test samples decreases with increase in bitumen content and VFB increases with increase in bitumen content.

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