Warm mix asphalt for cold weather condition

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ABSTRACT

Improved environmental responsiveness and stricter emission policy have led to a growth of warm mix asphalt (WMA) to reduce the high mixing temperatures of regular hot mix asphalt (HMA). Its benefits are reduction in energy consumption during production and reduced emissions during production. All methods reduce the viscosity of the binder at a sure temperature range, allowing the aggregate to be fully coated at lower temperatures than in HMA production.

These are mentioned below.

- The possibility of placement at a lower temperature. Important when there are long haul Distances.
- Reduction in energy consumption and lower emissions.
- Reduction in energy consumption and environmental factors.
- Reduction in energy consumption during production is a factor that will be use to evaluate the advantage of WMA if it will lower the overall cost of a project.
- Reduction in energy consumption because of lesser temperatures, longer paving period and lesser environmental impact of production and placement in urban areas.

Key words: Warm mix asphalt (WMA), Hot mix asphalt (HMA), Bitumen, Coarse aggregate and Fine aggregate

1.INTRODUCTION

Warm Mix Asphalt (WMA), a new paving skill that originates in Europe, is one of those efforts. It allows a reduction in the temperature at which asphalt mixes are produced and placed. It benefit are reduction in energy consumption and reduced emission from burning fuel, fume and odors generated at the production plant and the paving site. This paper investigate the potential use of warm mix asphalt in cold weather condition and specifically how countries like Iceland, with such conditions, can benefit from this technology. Early study has mainly focused on the environmental benefit and the reduced energy consumption of the technology and not as much on how its functions in cold weather paving.
The primary objective of this research is to find out whether warm mix asphalt is a viable option for the paving industry in Iceland. In the process of answering that question, warm mix asphalt's merit and demerit compared to traditional hot mix asphalt (HMA) are explored and the question of whether warm mix asphalt is a viable paving option for cold weather conditions in general is also answered. The conclusion of this paper are primarily drawn from a literature review that was conducted on warm mix asphalt to evaluate what is known about its performance and a survey that be conducted in Iceland by giving out a feedback form to professionals in the industry.

2.METHDOLOGY

Cold mix design is performed same as in Hot mix design but in a cold mix design using a binder as a emulsion. It depends on workability, durability, extensibility and required cold weather condition.

Cold mix asphalt must be designed and should possess better properties like temperature, uniform mix, durable for a long distance. Properties are governed by a temperature this is a low temperature based mix these reason that is called as a cold mix.

Range of mix proportions for cold mix design are as a 10mm aggregate 30%, 6mm aggregate 32% ,4mm down aggregate 38% and binder content is a 8%.There are many methods available for mix design which vary in the size of the test specimen, compaction, and other test. Marshall method of mix design is the mainly accepted one and is discussed below.

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MARSHALL TEST RESULTS																
Grade of Emulsion					RS-1				Date of Casting & Testing :							
Source of Aggregate					Shivrajpur Stone Quarry				Type of Material :				Emulsion			
Apparent Specific Gravity of Combined Aggregate (Gsa)					2.625				Number of blows:				50 on each face of specimen			
Bulk specific gravity of aggregate (Gsb)					2.519				Sp.Gravity of Emulsion (Gb) :				1.020			
Effective specific gravity of aggregate (Gse)					2.530				ProvinG Ring Factor (kgs) :				1.18			
% of Emulsion by wt. Of mix	**% of aggregate**	**Wt. In Air (gm)**	**wt. In water (gm)**	**SSD wt (gm)**	**Volume**	**Density = gm/cc (Gmb)**	**Gmm**	**Air Voids (%)**	**VMA (%)**	**VFB (%)**	**P.R.R (Div)**	**Load (Kg)**	**Corr. Factor**	**Corr. Load (Kg)**	**Corr. Load (KN)**	**Flow (mm)**
a	b	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r
7.00	93.00	1283.8	680.0	1285.5	605.5	2.120					160	188.8	0.78	147.3		2.4
		1282.1	681.2	1284.1	602.9	2.127	**2.292**	**7.46**	**21.69**	**65.61**	171	201.8	0.78	157.4		2.5
		1284.6	679.2	1286.4	607.2	2.116					155	182.9	0.78	142.7		2.4
Average						**2.121**								**149.1**	**1.5**	**2.4**
7.50	92.50	1289.8	690.2	1291.1	600.9	2.146					214	252.5	0.78	197.0		3.0
		1288.9	689.1	1289.9	600.8	2.145	**2.277**	**5.62**	**21.09**	**73.35**	229	270.2	0.78	210.8		3.2
		1290.4	693.5	1291.9	598.4	2.156					218	257.2	0.81	208.4		3.4
Average						**2.149**								**205.4**	**2.0**	**3.2**

Average	9.00			Average	8.50			Average	8.00		
	91.00				91.50				92.00		
	1309.1	1310.2	1308.6		1302.8	1303.2	1302.5		1297.8	1296.9	1296.2
	702.6	703.0	705.5		699.8	705.4	703.3		701.4	699.8	702.3
	1311.4	1312.8	1310.5		1304.0	1305.1	1303.9		1298.8	1297.8	1297.1
	608.8	609.8	605.0		604.2	599.7	600.6		597.4	598.0	594.8
2.154	2.150	2.149	2.163	**2.166**	2.156	2.173	2.169	**2.173**	2.172	2.169	2.179
2.233				**2.247**				**2.262**			
3.54				**3.60**				**3.93**			
22.19				**21.32**				**20.64**			
84.05				**83.11**				**80.96**			
	217	221	207		234	230	241		255	261	247
	256.1	260.8	244.3		276.1	271.4	284.4		300.9	308.0	291.5
	0.78	0.78	0.78		0.78	0.78	0.78		0.81	0.81	0.81
197.9	200	203	191	**216.3**	215	212	222	**243.1**	243.7	249.5	236.1
1.9				**2.1**				**2.4**			
6.4	6.5	6.4	6.2	**5.3**	5.6	5.2	5.1	**4.4**	4.3	4.6	4.2

3.RESULTS

EMULSION MIX DESIGN SUMMARY

Type of Material	Proposed Percentage of Blending
10mm Agg.	**30.00%**
6mm Agg.	**32.00%**
4mm Down	**38.00%**

Table 1. Permissible Variations in The Actual mix from the job Mix Formula As Per MoRTH Sec.500 Table 500-44

SI No.	Sieve Size mm	Proposed % of Passing	Permissible variation	JMF Limits	Specification Limits
2	13.2	100.0	± 6%	**100.0 - 100.0**	100
3	9.5	95.79	± 6%	**90.0 - 85.5**	90-100
4	4.75	68.90	± 5%	**60.0 - 62.9**	60-80
5	2.36	46.46	± 4%	**43.2 - 51.2**	35-65
8	0.3	16.44	± 3%	**18.9 - 24.9**	6-25
10	0.075	5.23	± 1.5%	**4.7 - 7.7**	2-10

The Marshall test were conducted at varying Emulsion content from **7 %** to10**%** in steps of **0.50%** . The optimum Emulsion content is obtained as **8.0%** by total weight of bituminous Concrete. The marshall stability and other design parameters are given in the Table 2.

Table 2. The Results of Cold mix at 8.0% of Emulsion (As per Graph)

SI No.	Description of the test	Results	As per Morth Section 500 Table 500-11 and 12
1	Number of Compaction blows on each face of Marshall Specimen	**50**	50
2	Marshall Stability (KN at 22.5^{0}C)	**2.4**	Min 2.2 KN
3	Marshall Flow value in mm	**4.4**	MIN.2
4	Air Voids in Compacted Mix %	**3.93**	3 -5
5	Laboratory Density of Mix (gmb) gm/cc	**2.173**	-
6	% Voids Filled with Bitumen (VFB)	**72.0**	65-75
7	Maximum Specific Gravity of Paving Mix (Gmm)	**2.262**	-
8	%Voids in mineral aggregate (VMA)	**20.64**	Min. 16
9	Emulsion Content %by weight of total mix	**8.00**	Min. 7.0

The Tests Results of Coarse and Fine Aggregate			
SI No.	**Description of the test**	**Results**	**As per MoRTH Specification Section 500 (Table 500-16)**
1	Aggregate Impact Value	17.65	Max. 24 %
2	Los Angles Abrasion Value	21.02	Max. 30%
3	Combined Flaky & Elongation	20.00	Max. 35%
4	Water Absorption	1.17	Max. 2 %
5	Plasticity Index of Fine Aggregate passing of 0.425 mm sieve.	Non- Plastic	Max 4 %
The Tests Results of Emulsion RS 1			
SI No.	**Description of the test**	**Results**	**As per IS:73 - 2013**
1	Residue on 600 micron	0.03	Max 0.05
2	Binder Residue by evaportion	70.0	Min 60
3	Viscosity at 50^{o} C	70.0	20-100
5	Specific Gravity of Emulsion	1.020	Min 0.99

4.CONCLUSION

Mix design results showed that different emulsions content have no significant effects on optimum binder content used in this study. The laboratory measurements the WMA mixes and the HMA control mix. The variations in observed strength appear to be due to differences in conditions under which cores were retrieved and normal measurement fluctuations. The working temperatures of the warm asphalt mixes were 38.0°F (21.1C°) to 65.8°F (36.5C°) lower than the HMA. Warm asphalt technology seems to be quite promising. It consumes 30% less energy, reduces carbon dioxide emission by 30%, and reduces dust emission by 50-60% compared to hot mix asphalt. This technology does not involve any major change to the mixing plant and the creation formula. Further research is needed so as to validate the expected field performance of such a mix.

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