Assessing the Efficacy of Warm Mix Asphalt

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Abstract - This paper focus on the research of the attributes and performance of warm mix asphalt containing compound added substance. Viscosity grade 30 bitumen was used for this study and the WMA added substances used as a part of this review were Evotherm and Sasobit. Consistency tests demonstrated the utilized warm mix additives are within permissible limit. Information got from indirect tensile test, tensile strength ratio test demonstrated that the blends containing warm mix asphalt added substances performed better in contrast with hot mix asphalt. Warm mix asphalt samples indicated lesser aggregate lasting strain gathering in contrast with HMA specimens, Sasobit altered warm mix asphalt specimens demonstrated the minimum deformation.

Key Words*: *Warm Mix Asphalt; Marshall Stability; Moisture Susceptibility

1. INTRODUCTION

The hot mix asphalt (HMA) industry searches for rising developments that diminish natural impact in the midst of formation of bituminous clearing materials. Warm mix asphalt is nonspecific term for a grouping of advances that allow the creators of hot mix asphalt to cut down the temperatures at which the material is mixed and set all over the place in India (Hurley and Prowell, 2004 and Anderson et al. 2008). The possibility of WMA was introduced in late 1990's in Europe. After that different WMA shapes have been made in Europe and the United States (Mallick et al. 2007, Prowell et al. 2007). Regardless of the way that there is no standard measure of workability of dark best clearing blends, a couple of researchers have made correct tests to check workability of clearing mix for relative purposes. A couple of researchers have used workability tests as a piece of an undertaking to choose which WMA advancements give improved workability, what estimation of WMA included substance gives perfect workability and compaction (Bennert et al. (2010). The mixing and compaction temperatures are typically chosen the introduce of the temperature-consistency chart. The thickness is considered as a suitable marker for the estimation of cover workability (Airey et al., 2008). Cut down mixing temperatures can achieve poor bitumen covering and along these lines make the bituminous mix powerless to suddenness hurt (L Mo et al., 2012). Decreased compaction temperatures furthermore provoke to lacking mix compaction which can achieve inopportune asphalt disappointment. Writing study reveals that consistency diminish is by all record not by any means the only framework that backings decreased creation temperatures for WMAs (Hanz et al. (2010), yet the lubricity effects of these warm blend included substances into the latch were essential to propel blend workability and compact ability at bring down temperatures (Fabricio and Randy, 2008). This paper hopes to inquire about the execution of warm mix asphalt containing two primary classifications of WMA innovations included substances at brought down temperature, which can lead down to a decrease in configuration black-top substance if joined in the mix setup process.

2. RESEARCH RUBRIC

2.1 AGGREGATE TEST FOR THE BITUMINOUS PAVEMENT

Aggregate with specific characteristics is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity. The aggregate properties are shown in Table 1

Table 1 Summary of Aggregate Test

Sr. No	Property	Test	Recommended Value as per MoRTH 500-8	Test Results
1	Cleanliness (dust)	Grain size anallysis	max 5% passing 0.075 IS- Seive	pass 30-ret 24mm-0.34%
				pass 24-ret 14 mm-0.46%
				pass 14-ret 6mm-0.81%
2	Particle shape IS:2386(part-1)-1963	Flackiness and Elongation Indices(combined)	35% max	28%
3	Strength,IS-2386(part-4)-1963	aggregate impact value	27% max	14%
4	Durability IS-2386(part-5)-1963	Soundness		
		Magnesium sulphate	max 18%	0.58%
		Sodium sulphate	max 12%	0.27%
5	Stripping IS-6241	Coating and stripping bitumen aggregate mixtures	min retained coating 95%	93%
6	Water absorption value,IS:2386(part-3)-1963	water absorption	2% max	1.24%

Representative samples of each aggregate were obtained from producer stockpiles, chikhali quarry, Gujarat for the dense bituminous macadam (DBM) blend. An aggregate blend was determined to meet Job-Mix Formula (JMF) gradation requirements, designed for 26.5 mm nominal size aggregate gradation as per Indian Specifications as given in Table 2.

Table 2 Aggregate Gradation for DBM Grade II

IS Sieve Size(mm)	Recommended Range (MoRTH-500-10)	Grading Adopted(% passing)
	Total % by Weight of Aggregate passing	
37.5	100	100
26.5	90-100	92
19	71-95	85
13.2	56-80	70
4.75	38-54	48
2.36	28-42	36
0.3	7.0-21	15
0.075	2.0-8.0	6

2.2 BITUMEN TEST

VG-30 (Viscosity Grade) bitumen grade is chosen for the review. Two warm mix included substances particularly Sasobit and Evotherm were used to prepare warm blend cover. Each additional substance was mixed in required estimations by weight of the bitumen. To set up a warm mix cover, the folio was warmed up to a temperature of 140 - 150°C and required estimations of included substance was incorporated and mixed for 20 minute with high shear blender. Tests of Evotherm is acquired from MeadWestvaco and Sasobit from Sasol Company. The required measurements for Evotherm is 0.2% and for Sasobit is 1-3% according to the item rules of the organization. The diverse percent doses, 0.2%, 0.4% and 0.6% for Evotherm and 1%, 2% and 3% for Sasobit with VG 30 fastener was taken under as pilot ponder and to locate the most reasonable measurements from economy and toughness perspective. The examples were sans given of cost. The physical properties acquired are appeared in Table 3.

Table 3 Summary of test results of VG 30 Grade bitumen with and without warm mix additives

Characteristics of tests	VG-30	VG-30+0.2% E	VG-30+0.4%E	VG-30+0.6% E	VG-30+1%S	VG-30+2%S	VG-30+3%S	Min Limit	code
Penetration (mm)	65	57.8	57.2	56.1	45.2	46.4	47.6	min 45	IS:1203
Softening point (degree)	57	48	49	51	70	68	64	min 47	IS:1204
Ductility (cm)	70+	70+	70+	70+	70+	70+	70+	min 40	IS:1208
Absolute viscosity at 60 poise	2454	2478	2492	2515				min 2400	IS:1206(PART-2)
kinematic viscosity,135 cst	453	381	422	430	436	364	360	min 350	IS:1206(PART-3)
Characteristics of tests	VG-30	VG-30+0.2% E	VG-30+0.4%E	VG-30+0.6% E	VG-30+1%S	VG-30+2%S	VG-30+3%S	Min Limit	code
Penetration (mm)	67	56.8	56.2	55.1	45.2	45.4	46.6	min 45	IS:1203
Softening point (degree)	58	49	51	52	70	69	63	min 47	IS:1204
Ductility (cm)	70+	70+	70+	70+	70+	70+	70+	min 40	IS:1208
Absolute viscosity at 60 poise	2456	2477	2494	2514				min 2400	IS:1206(PART-2)
kinematic viscosity,135 cst	453	381	422	430	436	364	360	min 350	IS:1206(PART-3)

Marshall Mix Design This test methodology is utilized as a part of planning and assessing DBM mixes and is widely utilized as for the paving jobs. Appropriately composed bituminous blend will withstand substantial loads due to traffic loads under antagonistic climatic conditions furthermore satisfy the prerequisite of auxiliary and asphalt surface qualities. At first the Marshall Test specimens are set up in agreement to the standard method for DBM Grade II (MoRTH-500-10), with chose total reviewing and differing bitumen substance are arranged and tried for assessing

Marshall Properties. The Marshall method of mix design was employed to design the mixture for dense bituminous macadam as shown in Table 4

Table 4 Volumetric Properties of VG 30

% Bit. By weight of mix	Bulk sp. Gr.(Gmb)	Stability(KN)	Voids in mineral agg. VMA (%)	Voids filled with bitumen VFB(%)	Flow (mm)	Air Voids VA (%)		Parameters	Binder content 4.52(%)
3.5	2.52	10.87	14.07	48.36	1.55	7.25		Stability (KN)	13.28
4	2.566	13.04	12.86	65.32	2.7	4.45		Bulk Sp. Gr.	2.587
4.5	2.58	13.34	12.86	70.86	3.06	3.74		VA(%)	3.54
5	2.572	12.29	13.58	75.31	4.05	3.37		VFB(%)	72.17
5.5	2.566	10.72	13.72	78.43	4.94	2.97		VMA(%)	12.67
Limit	……	min 9	12.0-15.0	65-76	2.0-4.0	3.0-5.0		Flow	3.06

Table 5 Volumetric Properties of VG 30 with Evotherm at 4.52% OBC

SUMMARY OF TEST RESULTS FOR VG-30 WITH EVOTHERM FOR DBM MIX DESIGN GRADING 2										
EVOTHERM	0.2% Evotherm			0.4% Evotherm			0.6% Evotherm			Limits
TEMP.	110	120	130	110	120	130	110	120	130	…….
CDM,gm/cc	2.52	2.563	2.544	2.512	2.531	5.532	2.558	2.566	2.564	…….
AIR VOIDS (%)	4.73	4.40	5.10	5.61	5.98	5.27	4.5	4.11	3.96	3.0-5.0
VMA(%)	13.72	13.37	13.94	15.05	14.52	13.82	13.5	13.37	13.44	12.0-15.0
VFB(%)	65.43	66.97	63.03	62.60	58.72	61.98	66.17	69.24	70.46	65-75
STABILITY (KN)	10.23	11.83	10.95	9.86	11.35	10.12	11.02	11.77	11.36	min 9
FLOW(mm)	2.16	3	3.34	2.66	3.1	2.84	2.85	3	3.16	2.0-4.0

Table 6 Volumetric Properties of VG 30 with Sasobit at 4.52% OBC

SUMMARY OF TEST RESULTS FOR VG-30 WITH SASOBIT FOR DBM MIX DESIGN GRADING 2										
EVOTHERM	1% Sasobit			2% Sasobit			3% Sasobit			Limits
TEMP.	110	120	130	110	120	130	110	120	130	…….
CDM,gm/cc	2.532	2.54	2.567	2.554	2.575	2.544	2.50	2.524	2.516	…….
AIR VOIDS (%)	4.62	3.26	3.53	4.94	4.6	5.42	5.68	4.24	3.83	3.0-5.0
VMA(%)	14.55	13.22	13.28	12.14	11.33	12.45	13.4	13.05	13.33	12.0-15.0
VFB(%)	68.3	75.24	78.45	59.36	63.77	56.64	58.3	67.28	71.46	65-75
STABILITY (KN)	8.55	9.46	9.29	8.54	10.22	9.92	9.23	11.21	10.04	min 9
FLOW(mm)	2.16	3.24	3.4	2.66	3.4	3.4	2.24	3.5	3.76	2.0-4.0

Table 7 Optimum additive dose and mixing temperatures

Binder	Dosage %by weight of binders	Mix temperature
VG-30+Evotherm	0.2	120
VG-30+Sasobit	3	120

The OBC (optimum binder content) for VG-30 was 4.52% by weight of mix respectively. For each performance test three Marshall Samples were prepared and tested, and average values of the results have been reported.

The estimations and the temperature at which WMA tests gave tantamount esteems as HMA were picked as the perfect measurement of included substance and the perfect mix temperature for two sorts of latches. It included arranging of Marshall Specimens at different measurements of an additional substance and at various temperatures going from 110°C to 130°C. Table 5 and 6 demonstrates eventual outcomes of this some part of examination. Control trial of HMA were made at 155-160ºC for VG30 folio. Table 7 demonstrates the ideal added substance dosage and blending temperatures of warm blend added substances.

Moisture Susceptibility Test the dampness weakness of the bituminous mix with warm mix included substances was evaluated by estimating the TSR as per ASTM: D 6931-12. The ITS of the mix is settled earlier and after that thereafter trim of Marshall examples and the TSR is then discovered as the extent of interesting quality and held quality after stimulated sogginess forming. The air voids in each one of these tests were kept up at 7 ± 1 %. For trim of the Marshall

tests, these were immersed in water shower at 60°C for 24 h and from that point kept at 25°C for 2 h. Table 8: Dry and Wet ITS estimations of various Mixes at OBC of Warm blend added substances.

3. CONCLUSION

Conclusion the execution tests directed on Marshall Specimens VG-30 bituminous mix with and without warm mix added substances demonstrated that warm mix arranged would be wise to protection from dampness powerlessness and changeless distortion than control hot blends. VG30 blends containing the warm mix asphalt added substances had fundamentally higher TSR esteems than control mix which demonstrates warm black-top blends indicated better protection from dampness incited harm and under static stacking this would additionally suggest that treated blends seemed, by all accounts, to be equipped for withstanding bigger tractable worry preceding breaking, likewise warm black-top blends indicates higher recuperation than control blends. Additionally air voids are seen inside passable point of confinement which likewise shows more prominent protection from rutting, however slight change in diminishment of ITS is seen. It can be plainly observed that the expansion of the added substances appears to positively affect the quality of the examples. One might say that the quality is conversely relative to air voids. Evotherm shows the base sogginess shortcoming took after by Sasobit and Evotherm (0.2%) fulfills the farthest point while other wma added substances are having marginally bring down cutoff at that point endorsed by code (≥ 80). Likewise have more grounded low temperature breaking protection property. Control HMA blends demonstrated more lasting collected strains in powerful crawl tests than WMA blends. This demonstrates warm black-top blends will have more protection from lasting disfigurement than the hot black-top blends.

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