iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VII **Month of publication:** July 2017

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 5 Issue VII, July 2017- Available at www.ijraset.com

Laboratory Evaluation of WMA with Zycotherm Warm Mix Additive

Raveesh J[1], Manjunath SM [2]
[1]*Assistant professor, Department of Civil Engg , Atria institute of technology,*
[2]*Assistant professor, Govt. SKSJTI, Bangalore*

Abstract: Warm mix asphalt (WMA) is a technology is allows significantly lowering the bituminous production and paving temperature of conventional Hot mix asphalt (HMA). The WMA is prepared by mixing chemical additives to conventional mix to improve the pavement performance and reduce the temperature upto 100 ^{o} C and even lowering without compromise of quality. In this study an attempt is made to compare the Marshall properties and water sensititivity of WMA produced with the chemical additive "Zycotherm" and HMA for bituminous (BC) Grade-2
Keywords: Zycotherm, VG grade, HMA, WMA, BC grade

I. INTRODUCTION

Warm mix asphalt is emerging and fastest growing technology in asphalt pavement which has a potential of revolutionizing the production of asphalt mixes. In this technology allows the mixing, laydown and compaction of asphalt mixes at significantly lower temperature compared to hot mix asphalt (HMA). Its benefits are reduction in energy consumption and reducing emissions from burning fuels, fumes and odour generated at the production plant and also at laying site.

II. LITERATURE REVIEWS

A. *National Centre for Asphalt Technology (2004 & 2005)*

Conducted a field demonstration project on a parking lot in Florida**.** The WMA mix discharge temperature was 36 °C lower than the control mix. WMA mix was found more workable than the control mix at the site and mix densities were the same for both sections. On carrying out observations after some months, no distress was observed in either section. Testing of extracted cores indicated that there was no difference in moisture damage resistance between the WMA and the control mix. However, it was stated that these sections didn't receive regular traffic.

B. *Kridan et al. (2010)*

Developed mix design procedures for warm mix asphalt using Marshall Method. They found that the addition of Sasobit additive in asphaltic mix reduces the air voids content in total compacted mixes. The general trend of increasing Sasobit additive in mixes on resilient modulus values was similar to the control mix at mixing temperature of 135°C. Asphaltic mix with Sasobit content of 1.5% and mixing temperature of 135°C complied with all the requirements set by Public Works Department, Malaysia Specification for Road works. There were no substantial differences in volumetric properties between the control mix and the Sasobit mix at 135°C.

C. *Xiao et al, (2010)*

Used one virgin binder (PG 64-22) and one Crumb Rubber Modified (CRM) binder (PG 64-22 + 10% 40 mesh rubber). Two aggregate sources (A and B) and two additives namely, Asphamin and Sasobit were used for the preparation of WMA mixes. From the results, it was observed that that fatigue life and stiffness of the rubberized WMA mixture from aggregate A is greater than aggregate B. the fatigue life of the mixtures made with crumb rubber and WMA additive is greater than the control mixtures (no rubber and WMA additive), except the mixtures containing Asphamin additive.

III. OBJECTIVES AND METHODOLOGY

A. *Objectives*

The main objective is to study the effect of using additive in modified and plain binder for HMA and WMA. The present study includes

1) The physical properties of bitumen by conducting basic tests

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2) The physical properties of aggregates by conducting basic tests to meet specifications
3) The physical properties of bitumen by conducting basic tests with added additive Zycotherm as an additive.
4) Evaluate potential impact of WMA on performance of flexible pavement.
5) To determine optimum bitumen content with different grades of binders such as VG-10, VG-30 and CRMB-55 by Marshall Method of mix design.
6) To determine the water sensitivity properties of both plain and modified binder.

B. *Selection Of Additive*

Zycotherm nanotechnology substantially improves coating of asphalt binder on aggregates, ensures consistent and higher compaction and eliminates stripping for making durable asphalt pavements over the service life. Zycotherm is WMA additive developed by zydex industries, gujarat, India. This is odour free chemical warm mix additive that has been engineered to provide improved benefits over current WMA technologies by offering lower production and compaction temperatures, while simultaneously enhancing the moisture resistance of pavements by serving as an antistrip. Mixes that have been modified with ZycoTherm can be produced at 120°C - 135°C for and compacted at 90°C - 120°C.

C. *Dosage*

1) Unmodified asphalt binders at 0.1% by weight of asphalt binder
2) Modified binders PMB/CRMB, RAP mixes at 0.135 % by weight of asphalt binder.

D. *Materials Requirements*

In this study, the design of bituminous concrete mix is carried out as per the MORTH specifications. The materials selected for the preparation of bituminous mixes in the present investigation are:

1) Aggregates
2) VG-10 plain bitumen
3) VG-30 plain bitumen
4) Crmb-55 grade modified bitumen

Aggregates: - For this study aggregates are selected in near tavarekere quarry from Bangalore

Bitumen: - Three different grades of bitumen were used in this work. Based on the viscosity grade VG-10, VG-30&CRMB-55 were adopted.

IV. METHODOLOGY

A. *The Following Methodologies Adopted in this Study are*

1) Basic tests on aggregate and different grades of bitumen.
2) Marshall Stability test for HMA VG-10, VG-30&CRMB-55.
3) Marshall Stability test for WMA 110^0 with VG-10, VG-30 &CRMB-55 using zycotherm as a warm mix additive adopting same OBC obtained in HMA.
4) Marshall Stability test for WMA 120^0 with VG-10, VG-30 &CRMB-55 using zycotherm as a warm mix additive adopting same OBC obtained in HMA.
5) Water sensitivity test to determine the Tensile strength Ratio on both HMA and WMA.

Table 1. Basic properties on aggregate

Tests on aggregates	Results	MORTH Specifications as per IS code 2386	Remarks
Aggregate impact value	23%	30% max	satisfactory
Aggregate crushing value	24%	30% max	satisfactory
Aggregate	25%	30% max	satisfactory

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abrasion value			
Specific gravity	2.68-20 down 2.69-12.5 down 2.70-4.75 down	>2.60	satisfactory

characteristics	results			Test method	remarks
	VG-10	VG-30	CRMB-55		
Penetration Test	82	67	59	IS-1203	Satisfactory
Viscosity 110^0C	540	680	900	-	satisfactory
Specific gravity	0.986	1.02	1.06	IS-1202	satisfactory

Table 2. Basic properties on Bitumen

B. Gradation as per JMF

In this present study three different sizes of aggregates (20 mm down, 12.5 mm down, 4.75 mm down) were considered. For this study BC-2 were adopted. Blending of aggregates proportions are

1) 23% for 20 mm down size
2) 22% for 12.5 mm down size
3) 55% for 4.75 mm down size aggregates

C. Specimen Preparation

1) Number of specimen: at least three specimens are prepared for each combination of aggregates and bitumen content.
2) Preparation of aggregate
3) Sieve analysis of aggregates
4) Preparation of compaction and mixing temperature
5) Preparation of mould and hammer
6) Compaction of the Specimen: this study 75 blows were applied on each side.
7) Basic parameters of Marshall Test: Mould is put out on Marshall Apparatus and Marshall Stability as well as Marshall Flow is measured by proving ring and flow dial gauge respectively. After that calculate the other factors like unit weight, VMA (%), VFB (%), etc.

V. DISCUSSIONS

Basic tests conducted on aggregates shows that it satisfied all the requirements as per MORTH IV revisions.

A. From the Marshall Stability values of HMA for VG-10, VG-30 & CRMB-55 grades of bitumen are 1525, 1444& 1594 respectively.
B. Marshall Stability values of WMA temperature 110^0C for VG-10, VG-30 & CRMB-55 grades of bitumen are 1515, 1402.89& 1501.34 respectively.
C. Marshall Stability values of WMA 120^0C for VG-10, VG-30 & CRMB-55 grades of Bitumen are 1549, 1493.34& 1611.02 respectively.
D. Marshall Flow values of HMA for VG-10, VG-30 & CRMB-55 grades of bitumen are 3.48, 3.8& 2.63respectively.
E. Marshall Flow values of HMA for VG-10, VG-30 & CRMB-55 grades of bitumen are 3.77, 3.23& 2.6 respectively.

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F. Marshall Flow values of HMA for VG-10, VG-30 & CRMB-55 grades of bitumen are 3.27, 3.1& 2.52 respectively.
G. Marshall Air voids values of HMA for VG- 10; VG-30 & CRMB-55 grades of bitumen are 4.16, 3.9& 3.57 respectively.
H. Marshall Air voids values of HMA for VG-10; VG-30 & CRMB-55 grades of bitumen are 3.35, 3.09& 3.77 respectively.
I. Marshall Air voids values of HMA for VG-10; VG-30 & CRMB-55 grades of bitumen are 2.26, 2.25& 2.77respectively.
J. Fig1 showed warm mix asphalt (Zycotherm additive) with a reduced temperature of 40 to 50^{o} C did not affect the strength in bituminous mix to a greater extent.
K. The Marshall Stability Test results given in fig1 shows Modified binder CRMB -55 has higher stability in comparison to plain binders such as VG-10&30 in both HMA and WMA. Also WMA 120^{o} C has good stability values compared to WMA 100^{o}C and HMA.
L. WMA 100^{o} C has lesser stability compare to HMA mix.
M. Based on water sensitivity or TSR test WMA gives higher TSR values as given in Table 3
N. The increase tensile strength ratio is observed for the mixes prepared using CRMB-55 both for HMA and WMA. This result in higher resistance to the damage associated with moisture.

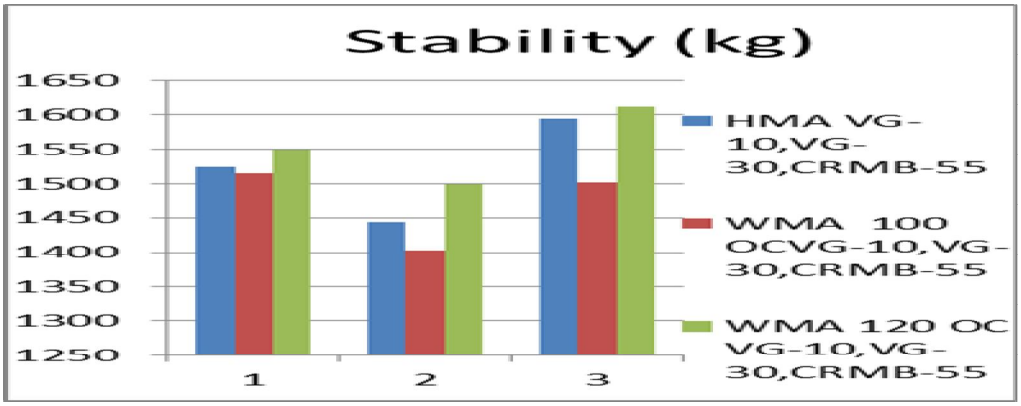

Fig 1: Marshall Stability results for both HMA and WMA

VI. CONCLUSIONS

The effect of Zycotherm on the mechanical behavior of bitumen is studied by performing the mix design, Marshall Stability, water sensitivity tests. The presence additive showed improved performance when compared with reference mix.
The following conclusions are made from the present study.

A. The WMA using Zycotherm is giving the satisfactory results.
B. Addition of Zycotherm additive in bituminous mix helps in reducing the mixing temperature for bituminous mix.
C. The Marshall stability has been increased with Zycotherm in plain and modified binders.
D. As an alternative of HMA, WMA in 120 ^{o}C can be used for road construction.

Water sensitivity test results (TSR) indicated warm mix asphalt showed better performance than hot mix asphalt.

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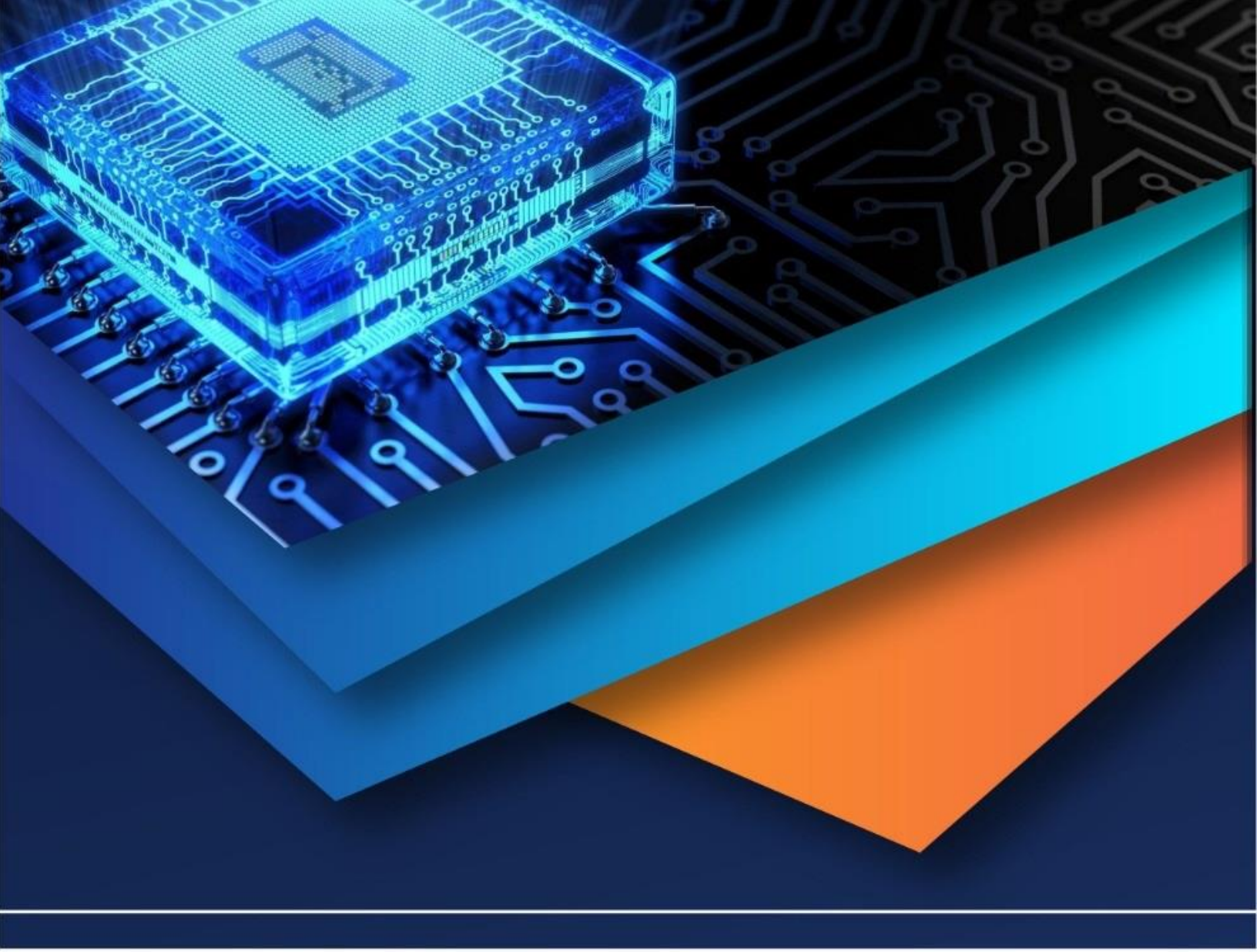

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