iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** V **Month of publication:** May 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Critique of Warm Mix Additive in Mix Design

Shaleha I. Vahora[1], Prof. C. B. Mishra[2]
[1]M. Tech Transportation Engineering student, Department of Civil Engineering, BVM Engineering College, V.V.Nagar, Anand, India.
[2]Associate Professor, Department of Civil Engineering, BVM Engineering College, V.V.Nagar, Anand, India.

Abstract: -WMA (Warm Mix Asphalt) is an innovative technology which is rapidly emerging in India which takes a prospective step towards conserving resources while addressing growing environmental sustainability. WMA technology allows the mixing, lay down, and compaction of asphalt mixes at significantly lower temperatures compared to Hot Mix Asphalt (HMA). The technology can reduce production temperatures by as much as 30 percent. This paper presents a systematic laboratory study and Marshall Mix Design for DBM grade II for warm mix additive (WMA) i.e. Rediset LQ. Engineering properties of Virgin bitumen (VG30) and WMA mixes were experimentally evaluated and further Marshall Mix design is carried out to find the Optimum Bitumen Content (OBC) of VG30 and Optimum dosage and Optimum temperature required by Warm mix additive (Rediset LQ added Asphalt) to satisfied the codal provisions. And the effects of Rediset LQ Additive in terms of low temperature, High stability, Increase in viscosity and Workability were investigated. These effects indicated the suitability of this WMA technology for the construction of sustainable and long lasting roads.
Keywords: WMA (warm mix asphalt), dense bitumen macadam (DBM), Marshall Mix, Rediset LQ chemical, Aggregates.

I. INTRODUCTION

The hot mix asphalt (HMA) production is continuously keep an eye for techniques which need to advance pavement performance, increase the efficiency of construction, and preserve resources, and improvement in the environmental control. In order to grasp these objectives, warm-mix asphalt (WMA) technologies is now consider to be best option as it's help to decrease the bitumen viscosity and allows the mixing and compaction of the mix comparatively lower temperature by about 30–55°C as compare to conventional HMA.

There are number of benefits of WMA, including (1) Reduction in temperature leads to reduce the energy consumption and causing reduction in CO2 emission which directly reduce the environmental impacts and improved sustainable development (2) Reduction of viscosity enhance the improvement in field compaction thus extending the paving season and allowing the possibility for longer haul distance, and (3) WMA produces lower fumes and odour both at the plant and the paving site compared to HMA. This would also result in improved working conditions at both places.

In the study, laboratory investigations needs to be carried out on VG 30 grade with and without different percentages of warm mix i.e. Rediset LQ to evaluate the enhanced engineering properties needed in the design of mix using Marshall mix design and the optimum bitumen content are evaluated and lowest temperature at which warm mix additive performs effectively needs to be recorded.

II. LITERATURE REVIEW

Now- a day's Warm Mix Asphalt (WMA) is broadly use everywhere throughout the world as a result of its quantities of points of interest when contrasted with Hot Mix Bitumen (HMA). Literature study supporting the work is as shown

A. Evaluation of Rediset for use in warm-mix asphalt: a review of the literatures

Meor Othman Hamzaha , Babak Golchina1, Ali Jamshidia and Emmanuel Chailleuxb (30 August 2014).This review paper presents the effects of a chemical warm mix additive, named Rediset on the rheological properties of asphalt binders, laboratory performance of asphalt mixtures, field behaviour of constructed road sections, energy consumption and air pollution, physicochemical properties of asphalt binders and behaviour of asphalt mortar.

B. Warm mix asphalt: Paves way for energy saving

Rajan Choudhary and Ashok Julaganti (June 2014), describe the Warm mix asphalt technology, its benefits and disadvantage. Further it's explain that how WMA technology is advantageous as compare to Hot Mix Asphalt. The main concern with the production of HMA is, it requires large amount of energy and also releases enormous amount of emissions into the environment.

C. Warm Mix Asphalt: An overview

Ma Carmen Rubio Gámez, Germán Martínez. This paper is an outline of the different technologies used in the engineering of WMA. It examines the materials, additives, mix design and performance of the asphalt made by this technology. It also defines its benefits and disadvantages, and emphasizes the need for further research in this area.

D. Analysis of Warm Mix Asphalt Additives,

Benjamín Colucci, Freddie Salado, (2014), a research study was conducted to evaluate additives Evotherm M1, Kaoamin 14, Sasobit and Rediset in WMA**.** Mixtures with the modified binders were evaluated for compaction, susceptibility to moisture and susceptibility to permanent deformation.

Anand Sampath (2010) studied the inclusive evaluation result of Sasobit, Evotherm J1 and Rediset TM related to flow number, viscosity, dynamic modulus, tensile strength and dampness.

Benjamín Colucci, evaluate additives Evotherm M1, Kaoamin 14, Sasobit and Rediset in WMA. Susceptibility to moisture results showed that Evotherm M1 with a TSR of 96.1% has less probability to stripping.

Lee & Kim, evaluate various WMA products with respect to their fundamental engineering properties and performance-related characteristics. And put the Evotherm J1 at 4th rank out of 10 products.

Zun jhang (2010) concentrated on the impacts of warm mix bitumen's added substances on black-top blend attributes and bitumen execution. The essential goal of this examination is to assess the plausibility of a few WMA blends as potential bitumen paving mixtures furthermore; three surely understood WMA added substances were examined.

III. MATERIALS AND METHODOLOGY

A. Aggregates

Aggregates are the most mined materials in the world. Natural aggregates are taken out through an open excavation (quarry) from larger rock formations. Mechanical crushing is done to reduced extracted rock into the operating sizes. It is obtained from Savli.

B. VG30 (50/70 grade)

It is Viscosity graded bitumen having penetration ranges between 50-70mm act as a binder in road construction and retain good bonding and adhesion agent properties with aggregates. Furthermore it provide the good property of waterproofing and resistance to acids and alkali too.

C. Warm Mix Additive

Rediset LQ: Rediset LQ is WMA chemical additive grew by the Akzo noble company, Mumbai. Rediset LQ offers an easy-to-use liquid that is more than simply a warm-mix additive. It provide Superior workability and compaction even at reduced temperatures This is a warm blend added substance that has been made to give advantage over current WMA advancements by lowering the production and compaction temperatures

IV. . METHODOLOGY

In this work Dense Bituminous Macadam (DBM) mix is designed for Grade II section 500 clauses 507. The bitumen grade VG30 is collected from IRB Plant Gujarat. Rediset LQ chemical WMA additives collected from Akzo Nobel Company Mumbai .The aggregates are obtained from IRB plant, Pij chokadi, Nadiad.

Scientifically the tests on aggregates are evaluated in the laboratory as well as bitumen tests for VG30 with & without WMA additives (chemical) are perform which includes the Penetration test, Viscosity test, Softening Point test, Specific Gravity etc. which are as per IS standard and all results satisfied the IS specification.

The volumetric properties is worked out to determine the Optimum bitumen content (OBC) for which other samples with warm mix additives are prepared at 110°C, 120°C, 130°C temperature and at different dose of Rediset LQ i.e. 0.4%, 0.5%, 0.6% of weight of binder. From this the Optimum temperature and Optimum dose of Rediset LQ are found out.

A. Laboratory investigations

In order to authentify the acceptance of materials required tests are carried out as per codal provision (table 1 & 2):

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table 1: Physical properties of Aggregate

Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam grade - II (As Per MoRTH Table : 500-8)				
Sr. No.	Property	Test	Specification	Test Result
1	Cleanliness (dust)	Grain size analysis	Max 5 % passing 0.075 IS-Sieve	Pas.26.5.-Ret.22mm-0.33%
				Pas.24-Ret.14 mm-0.45%
				Pas. 14 -Ret. 8 mm-0.79%
2	Particle shape	Flakiness & Elongation Indices (Combined)	30% Max	27.79%
3	Strength	Aggregate Impact Value(AIV)	27 % Max	12.36%
4	Resistance to abrasion	Los angles abrasion test	35 %	18.20%
5	Water absorption value	Water absorption value	2 % Max	0.98%

Gradation of aggregate meeting MoRTH section 500-8

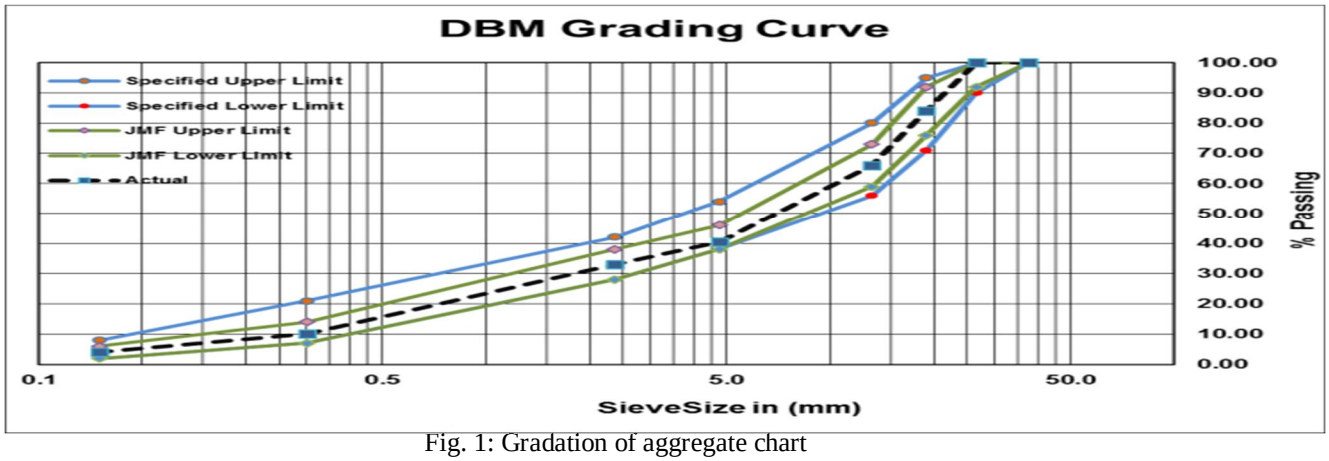


Fig. 1: Gradation of aggregate chart

It is clear from the above table that the limits are within the Upper and Lower limits satisfying JMF & MoRTH specifications for 26.5 mm nominal size of aggregate.

Table 2: Physical properties of VG 30 and VG30+% Rediset LQ

Characteristics of tests:	VG-30	VG-30 + 0.4 % Rediset LQ	VG-30 + 0.5 % Rediset LQ	VG-30 + 0.6 % Rediset LQ	Min. Limit	Code
Penetration (mm)	53.33	34	42	43	50/70	IS 1203
Softening point (C°)	52.5	52	51	54	47	IS 1205
Ductility (cm)	94	85	82	85.5	40	IS 1208
Absolute Viscosity at 60 (C°)	4640	4570	3960	3230	2400	IS 1206 (part 2)
Kinematic Viscosity at 135°C(cst)	652	596	557	555	350	

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

A. Marshall Mix design for optimum binder content(OBC) using VG30

For deciding the Optimum Bitumen Content, 6 specimens are arranged of bitumen substance at 4, 4.2, 4.4, 4.6, 4.8 and 5.0% of degree blend weight at blending temperature 160° C according to the system and prerequisites of MoRTH segment 508. The volumetric properties obtained are as shown in table 3.

Table3: Properties of Marshall Mix Design for DBM Grade II as per MoRTH (500-11).

% Bitumen By Weight of Mix	Bulk Specific Gravity (Gmb)	Stability (KN)	Voids in Mineral Aggregates VMA (%)	Voids Filled with Bitumen VFB (%)	Flow (mm)	Air Voids VA (%)
4.00	2.490	10.75	15.29	48.84	2.17	7.82
4.20	2.508	12.03	14.85	56.77	2.47	6.42
4.40	2.522	13.16	14.56	63.05	2.93	5.38
4.60	2.531	13.30	14.45	68.22	3.43	4.59
4.80	2.523	13.72	14.87	72.15	3.80	4.14
5.00	2.514	12.46	15.36	74.41	4.40	3.93

Parameters	Binder Content (%)
Stability (KN)	4.62
Bulk Sp. Gr.	4.60
VA %	4.63
VFB %	4.64
Average	4.62

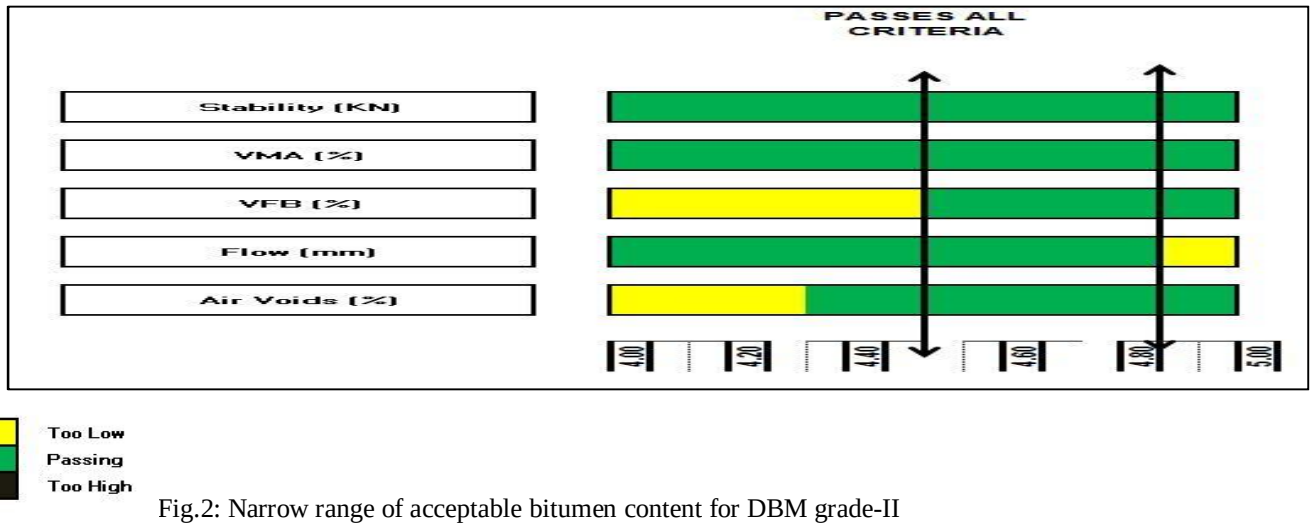


Fig.2: Narrow range of acceptable bitumen content for DBM grade-II

Optimum bitumen content: 4.62%

The ideal cover substance 4.62% fulfils the point of confinement set down in MoRTH segment 507-508 regarding greatest steadiness,

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Marshall Flow value, maximum stability, percentage air voids in compacted mix and voids filled with bitumen and, Bulk specific gravity. Fig. 2 shows narrow range of acceptable bitumen content.

B. Marshall Mix Design for VG30 (4.62 % OBC) *plus Rediset LQ for Optimum dosage and Optimum temperature.*

Different dosages of Rediset LQ are taken i.e. 0.4%, 0.5%, and 0.6% of Rediset LQ.

Graphs of all properties of each mix are plotted as shown in figure 3 to 8.

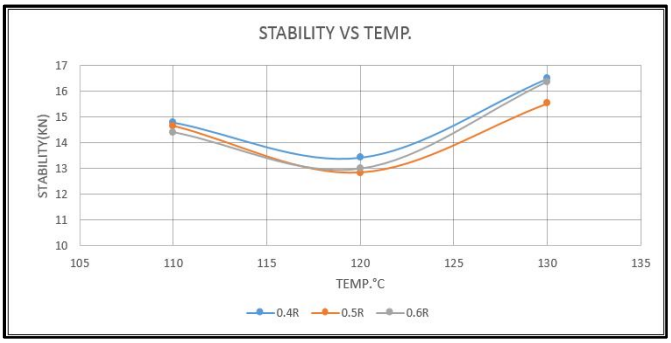


Fig. 3: Stability V/S Temperature

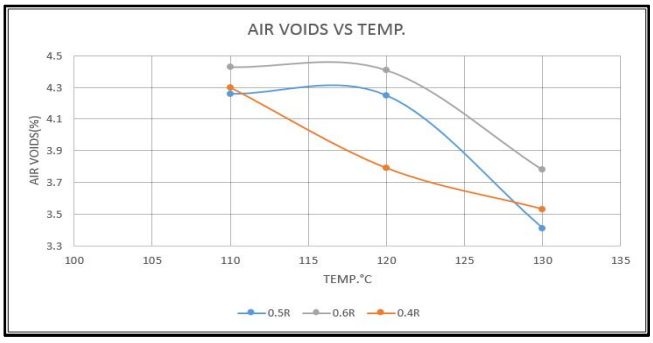


Fig. 4: % Air Voids V/S Temperature

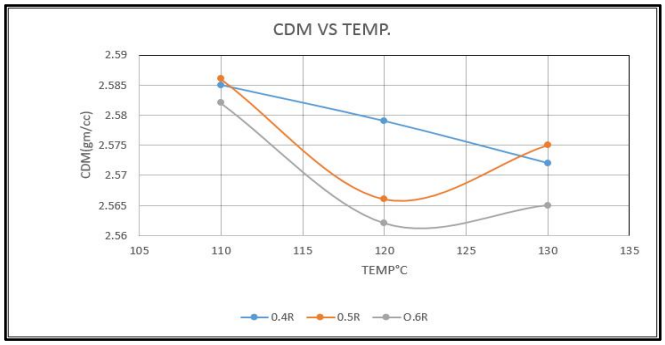


Fig. 5: Bulk Density V/S Temperature

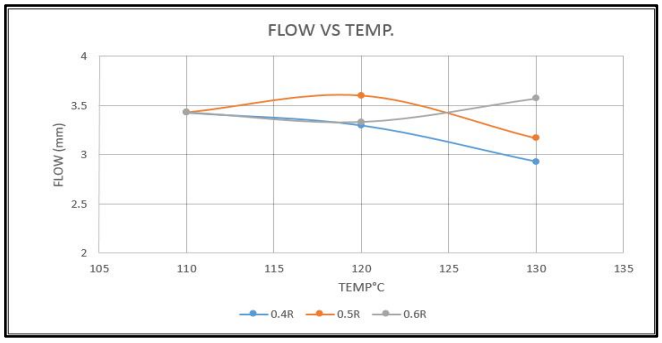


Fig. 6: Flow V/S Temperature

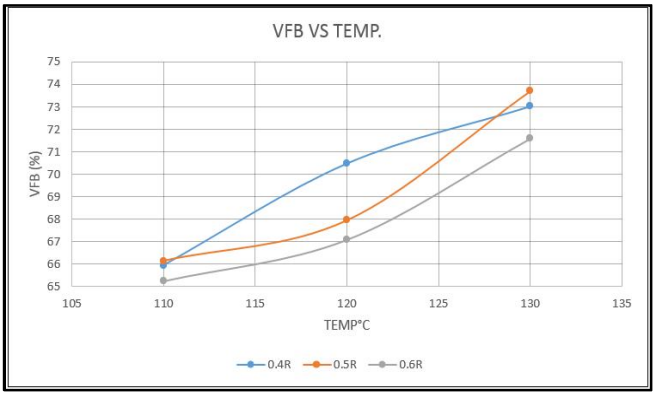


Fig. 7: %VFB V/S Temperature

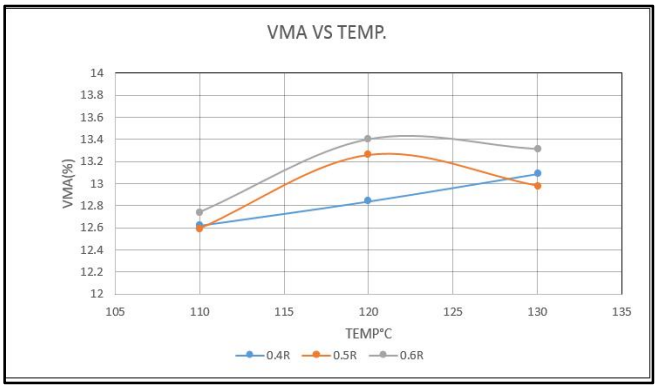


Fig. 8: %VMA V/S Temperature

V. CONCLUSION

From the different examinations completed in the laboratory taking after, conclusions are drawn:

A. Physical properties of aggregates are fulfilling the IS codes as shown in table1.

B. Aggregate gradation chart plot in figure1, shows that the obtained gradation line is maintain the central limit which indicates that packing interlocking would be good to resist deformation under heavy vehicle loads.

C. The properties of VG30 grade is investigated like penetration test, viscosity test, softening test, specific gravity and Ductility fulfilling the criteria as laid down in codal provisions for bituminous surface.

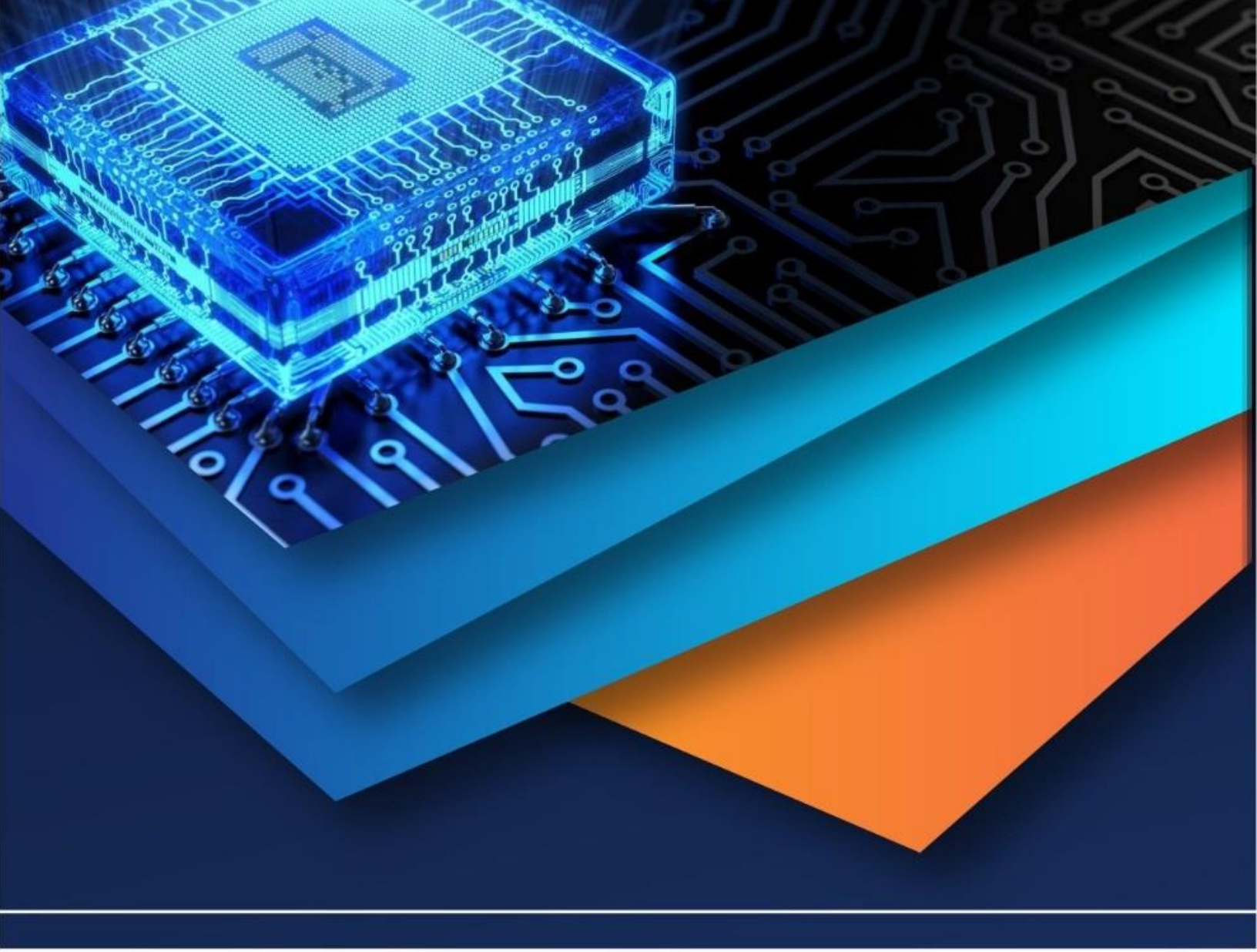
D. For VG 30 Marshall Mix Design DBM Grade II, the optimum binder content comes out to be 4.62% satisfying the permissible limits as per the MoRTH section 507.

E. The properties of VG30 grade + % additives (Rediset LQ) is investigated like penetration test, viscosity test, specific gravity, softening test, and Ductility test fulfilling the criteria as laid down in codal provisions for bituminous surface.

F. The corroborative test of Marshall Mix design utilizing VG 30 as 4.62% by weight of bitumen with 0.4 %, 0.5 % and 0.6% Rediset LQ as warm mix added substance demonstrates that VG 30 with 0.4 % Rediset LQ fulfils the criteria's set down in codal MoRTH procurement at 130°C, likewise it is seen that at this rate huge change in flow values, stability, and unit weight are watched for improving the compaction and increasing the workability conditions. This will bring down the fuel cost and pollution level too.

REFERENCES

[1] Anand sampath(2010), "Comprehensive evaluation of four warm asphalt mixture regarding viscosity, tensile strength, moisture sensitivity, dynamic modulus and flow number" University of lowa
[2] Brian D Prowell, Graham C. Hurley, Everett crews l(2007) Field Performance of Warm-Mix Asphalt Transportation Research Record Journal of the Transportation Research Board (Impact Factor: 0.44). 01/2007; 1998(1):96-102. DOI: 10.3141/1998-1
[3] Devendra K. Patel, Prof. C. B. Mishra, Prof. A. A. Amin (2014), " Evaluation of Rediset as Warm Mix Adhesion Promoter with CRMB 60 in Mix Design" International Journal of Engineering Research and Technology Vol. 3 (03), 2014, ISSN 2278 – 018
[4] IS: 1202- 1978, "Methods for testing tar and bituminous materials: determination of specific gravity".
[5] IS: 1203- 1978, "Methods for testing tar and bituminous materials: determination of penetration"
[6] IS: 1205- 1978, "Methods for testing tar and bituminous materials: determination softening point".
[7] IS: 1206- 1978, "Methods for testing tar and bituminous materials: determination of viscosity"
[8] IS: 2386 (Part 1) - 1963, "Methods of test for Aggregates for concrete: Particle size and shape".
[9] IS: 2386 (Part 3) - 1963, "Methods of test for Aggregates for concrete: specific gravity, density, voids, absorption and bulking"
[10] IS: 2386 (Part 4) - 1963, "Methods of test for Aggregates for concrete: Impact value and Abrasion value".
[11] IS: SP 53- 2002, "Guidelines on the use of Polymer Modified Binder Specifications".
[12] MeadWestvaco (2003), Evotherm warm mix asphalt-The next-generation sustainable paving solution. (www. majeskaassociates.com/ images/ Evotherm.pdf
[13] Ministry of Road Transport and Highways (MORTH), Government of India for Road and Bridge works, section 508, Design of Bituminous Concrete
[14] Rohith N., J.Ranjitha (2013) "A Study on Marshall Stability Properties of Warm Mix Asphalt Using Zycotherm A Chemical Additive", International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 7, July – 2013.
[15] Prithvi Singh Kandhal (2010) Warm Mix Bitumen Technologies: an overview Journal of Indian Road Congress.
[16] Yu Kuang (2012) Evaluation of Evotherm as a WMA technology compaction and anti-strip additive M.tech thesis, Iowa State University, Ames, Iowa.
[17] Zun Jhang (2010) Effects of Warm Mix Asphalt Additives on Bitumen Mixture Characteristics and Pavement performance Civil Engineering Theses, Student Research, University of Nebraska-Lincoln
[18] Meor Othman Hamzaha, Babak Golchina1, Ali Jamshidia and Emmanuel Chailleuxb (30 August 2014), Evaluation of Rediset for use in warm-mix asphalt: a review of the literatures.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY