iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** IV **Month of publication:** April 2022

DOI: https://doi.org/10.22214/ijraset.2022.41622

www.ijraset.com

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

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

Performance Based Testing on Bituminous Mixes using Roller Compactor cum Rut Analyser (RCRA)

Manjunatha S[1], Dr. B. V. Kiran Kumar[2]
[1]*Assistant Professor*, [2]*Associate Professor, Government SKSJ Technological Institute, Bangalore*

Abstract: ***In India majority of roads are being constructed by flexible pavements. But the performance of the pavement largely depends on quality of materials used, Equipment's used, construction methodology adopted, temperature and climatic conditions at the area etc. Because of these variations in the mentioned parameters, pavements undergo distress/ failure. The different types of failure in flexible pavement are Rutting, Shovelling, Edge breaks, Cracks, Slippage etc. Rutting is a common phenomenon which occurs in flexible pavement surface due to overloading of vehicles and repeated application of wheel load. Design of bituminous paving mixes greatly effects the performance of pavements. In the present laboratory research work, Bitumen grade VG-30 & VG-40 are used in wearing/ surface course and VG-30 is used in binder course of the layer to study the properties of Marshall Stability. An indigenously developed equipment called Roller Compactor cum Rut analyser (RCRA) is used to study the performance of these bituminous mixes against Rutting.***

Keywords: Job Mix Formula (JMF). Marshal Method, Bituminous Concrete (BC), Dense Bituminous Macadam (DBM) Roller Compactor cum Rut Analyser (RCRA).

I. INTRODUCTION

The development of transportation infrastructure has been closely linked with the human development. Transportation plays a major role in the development of economy and there by overall development of the country. In India majority of the roads are constructed are of flexible pavement. The performance of the pavement mainly depends on the mix design of bituminous mixes. Marshall Method of mix design is commonly adopted in India. A high value of Marshall Stability in the bituminous mix is an indication of stable, strong and durable mix

Also, temperature and climatic conditions of the area affects the performance of pavements. The common types of failure occurs in flexible pavement are pot holes, depression, shovelling, cracks, edge break, rutting etc. Rutting occurs in the pavement surface on all along the wheel path due to repeated load application of heavily loaded trucks. So, in the present laboratory research work, Marshall Stability test is conducted by casting the specimens on wearing course of bituminous mix along with binder course using VG-30 & VG-40 grade Bitumen. Also, Rutting test on the prepared specimens are casted by indigenously designed, developed and fabricated equipment called Roller Compactor cum Rut Analyzer (RCRA). Both these tests help in knowing the performance of bituminous mixes.

II. OBJECTIVES OF THE RESEARCH WORK

A. To conduct the basic tests on Aggregates, Bitumen in the laboratory as per the relevant IS/ MoRTH standards to ascertain its suitability for the use in research work.

B. Based on the obtained Job Mix Formula (JMF) for different bituminous mixes, Marshall Stability Test is conducted on wearing course of pavement layer namely, BC Gr-I & BC Gr-II with VG-30 & VG-40 along with binder course layer namely DBM Gr-II with VG-30.

C. To conduct the rutting test on casted specimens of bituminous mixes using Roller Compactor cum Rut Analyser (RCRA).

D. Comparison of obtained results of Marshall Stability and Rutting tests.

III. LITERATURE REVIEW

Lokesh Gupta et al.[1] A good bituminous mix design is anticipated to produce a mix which is supposed to be sufficiently sturdy, long-lasting, resistive.DBM is used as a binder course in the highway pavement. Binder is a prime material in the bituminous mix. Marshall Properties of bituminous mix varies from binder to binder. In this work an effort has been made to evaluate the Marshall properties of dense bituminous macadam prepared using VG-30 and CRMB-55 as binder materials. DBM mix is prepared using 2% lime as filler material and VG-30, CRMB-55 as binder material.

Marshall Method of Bituminous Mix Design is adopted to decide the optimum binder content (OBC) and Marshall Properties were determined at optimum binder content. On the basis of limited laboratory studies carried out, it is concluded that CRMB-55 is of superior binder material in terms of Marshall Properties.

Nikhil Saboo, et al [2] A good wearing course is necessary for the protection of flexible pavement to make it durable. While a wearing course of surface dressing has been known for its durability all over the world on low volume roads, the wearing course of premix carpet and seal coat is very common in India though frequent pothole repair and patching well within five years of construction are not uncommon.

The conventional BC wearing course in India where the hot climate prevails not been performing well on heavy volume highways with life not exceeding three years. Bituminous Concrete with Crumb rubber modified bitumen also has a success rate of less than 50% as per the survey by the senior author.

Polymer modified bitumen is less common because of higher cost. The paper presents an investigation on different types of wearing course of bituminous mixes to examine their likely field performance and suggest wearing course which may last longer. Binders such as VG30, VG40 and CRMB and PMB with dense and gap gradations were used in the investigations. It was found that high binder gap gradation bituminous mixes even with CRMB binder have a good chance to provide a long lasting low maintenance crack and rut free wearing surface on high volume highways rather than dense graded Bituminous Concrete with conventional binder. The authors discussed about cost and environmental issues.

Saradarali Mujavar, et al [3] Bituminous mix is very sensitive to the temperature. Its response to a given loading is strongly dependent on temperature. At high temperatures, binders behaves purely as ductile material, whereas at very low temperature their behaviour is purely breakable. In the present study, an attempt is made to design the bituminous concrete mixes by Marshall method using both Viscosity grade Bitumen (VG 30) and polymer modified bitumen (PMB 40) with two different fillers i.e., stone dust and Tiles powder.

The performance studies like Indirect tensile strength, moisture susceptibility also done. From the present study, it is concluded that polymer modified bituminous concrete (PMBC) mix with stone dust and tiles powder as fillers showed higher Marshall Stability when compared to bituminous concrete (VG-30) mix. It is observed that the polymer modified bituminous concrete (PMBC) mixes showed higher indirect tensile strength compared to bituminous concrete mixes.

Bereket Admasu Lambebo [4] Hot mix asphalt wearing course in a flexible road pavement is the most important and critical layer in a pavement structure and must be of high quality.

The major parameter in design of hot mix asphalt (HMA) for it to be both stable and durable is to find out the optimum bitumen content (OBC) required in achieving the desired objective. This article presents a mix design of bituminous concrete wearing course of flexible pavement. Laboratory tests were carried out on the aggregate, bitumen and paving mix samples. All the analysis were carried out in line with the ASTM testing procedures.

The result of sieve analysis showed that the particle size distribution of the aggregate is in ranges recommended by the national standard. The Aggregate Crushing Value (ACV), Aggregate Impact Value (AIV), LosAngels Abrasion (LAA) and Flakiness Index (FI) respectively are 12.5%, 13.02%, 18.11% and 25.32%. The results obtained showed that the aggregate in question do possess the required qualities to be used in a wearing course material as per the standard. With respect to the bitumen, it has a specific gravity of 1.01 at 75 number of blows.

The optimum bitumen content of the paving mix under study is 5.00%. Other mix parameters such as VMA (%), VFB (%), Stability (KN) and Flow (0.25mm) are found to be 13.35, 71.00, 18.60 and 12.48 respectively. When the mix parameter values are compared against the required standard intervals, all the mix Parameters above which are at the bitumen content of 5.00% lie well at the interval desired as per national and ASTM (MS-2) criteria

IV. METHODOLOGY

The following methodology is adopted in the present research work:

1) The methodology includes conducting the Basic tests on the materials used in the research work such as aggregate, bitumen as per the relevant IS/MoRTH Codal standards

2) Arrive at the suitable Job Mix Formula (JMF) and conduct Marshall Stability test on the prepared bituminous specimens.

Preparing the specimens for rutting and conducting rutting test by Roller Compactor cum Rut Analyser (RCRA) for BC Gr-II with VG-30 & VG-40 along with binder course layer namely DBM Gr-II with VG-30.

Fig 1: Roller Compactor cum Rut Analyser (RCRA)

The Fig.1 shows the Roller Compactor and Rut Analyser used in the laboratory for conducting the Rutting test.

V. LABORATORY TEST RESULTS

The laboratory investigation/tests were carried out on different materials used in the research work and the obtained results are as follows:

Table 1
Tests on aggregates

SL No.	Name of the Tests	Obtained Results	Method Adopted	Permissible Limit (as per IS/MoRTH)	Remarks
1	Aggregate Impact value test (AIV),%, max	15.16	IS:2386-PartIV	27.0	Satisfactory
2	Abrasion Value, %, max	23.5	IS:2386-Part IV	35.0	Satisfactory
3	Specific Gravity	2.65	IS:2386-Part III	2.5 –3	Satisfactory
4	Water Absorption,%, max	0.32	IS:2386-PartIII	2.0	Satisfactory
5	Shape Test, %, max	17.09	IS:2386-PartI	35.0	Satisfactory
6	Plasticity Index, max	2.5	IS 2720-Part V	4.0	Satisfactory

Table 2
Tests on Bitumen

Sl No	Name of the test	Obtained Results	Method adopted	Permissible values as per IS/ MoRTH	Remarks
1	Penetration Value ,mm, min	66.0	IS:1203-1978	45.0	Satisfactory
2	Softening point ,ºC, min	49.0	IS:1203-1978	47.0	Satisfactory
3	Flash & Fire point ,ºC, min	274 and 300	IS:1203-1978	220	Satisfactory
4	Ductility value, cm, min	85.0	IS:1208-1978	75.0	Satisfactory
5	Specific Gravity	1.00	IS:1203-1978	--	--

Table 3
Job Mix Formula (JMF) and Optimum Binder Content (OBC)

Sl No	Type of Bituminous Mix	Bitumen/ Modified Bitumen used	Percentages of Aggregate to be used as per Job Mix Formula (JMF)			OBC obtained based on Marshall Stability Test (%)
			Material A (26.5 mm down)	Material B (13.2 mm down)	Material C (4.75 mm down)	
1	BC Gr-I	VG-30	40	20	40	5.40
2	BC Gr-II	VG-30	20	20	60	5.60
2	DBM Gr-II	VG-30	30	30	40	5.10

Table 4
Results of Marshall Stability

Sl No	Marshall Property	Wearing course with VG-30		Binder Course with VG -30
		BC Gr-I	BC Gr -II	DBM Gr-I
1	Optimum Binder Content (OBC), %	5.40	5.60	5.10
2	Marshall Stability, kg	1914.0	2365	1190
3	Flow Value, mm	3.05	3.45	3.85
4	Bulk Density, gm/cc	2.365	2.374	2.355
5	Volume of Voids, %	3.44	3.25	3.05
6	Voids in Mineral aggregate , VMA, %	18.10	17.21	18.50
7	Voids filled with Bitumen, VFB, %	74.7	67.5	73.0

Table 5
Results of Rutting test on Wearing Course (BC Gr- I & BC GR-II) with Binder Course (DBM Gr-I)

Sl No	Rut Depth (mm)	Number of passes in Roller Compactor cum Rut Analyser (RCRA)	
		BC Gr-I with VG-30	BC Gr-II with VG-30
1	0	0	0
2	2	4302	5123
3	4	8910	9870
4	6	11458	13004
5	8	13109	15245
6	10	15040	17453
7	12	15830	19103
8	14	16380	19444
9	16	16982	20110
10	18	17675	20456
11	20	18020	20890

VI. DISCUSSIONS

A. The basic properties on aggregates, bitumen are carried out in the laboratory and the materials satisfies the requirements as per the relevant IS / MoRTH standards.

B. The Optimum Binder Content (OBC) for BC Gr-I & BC Gr-II with VG-30 is found to be 5.4 and 5.6% respectively. The OBC for DBM Gr-II with VG-30 is found to be 5.10%.

C. The Density of the bituminous mix is higher in BC Gr-II than in BC Gr-I mix

D. The Marshall Stability value of BC Gr-II is about 24% higher than BC Gr-I mix.

E. BC Gr-II shows 16% higher resistance to Rutting than BC Gr-I mix.

VII. CONCLUSIONS

From the present research work, it can be concluded that, the wearing course layer namely, BC Gr-I shows a higher Stability value and higher resistance to rutting than BC Gr-I when tested in the laboratory.

VIII. ACKNOWELEDEMENT

The Author/ Researcher thank Dr B V Kiran Kumar, who is also the co-author of this research paper in design, development, and fabricating the Roller Compactor cum Rut Analyzer (RCRA) Equipment which is used in this study.

REFERENCES

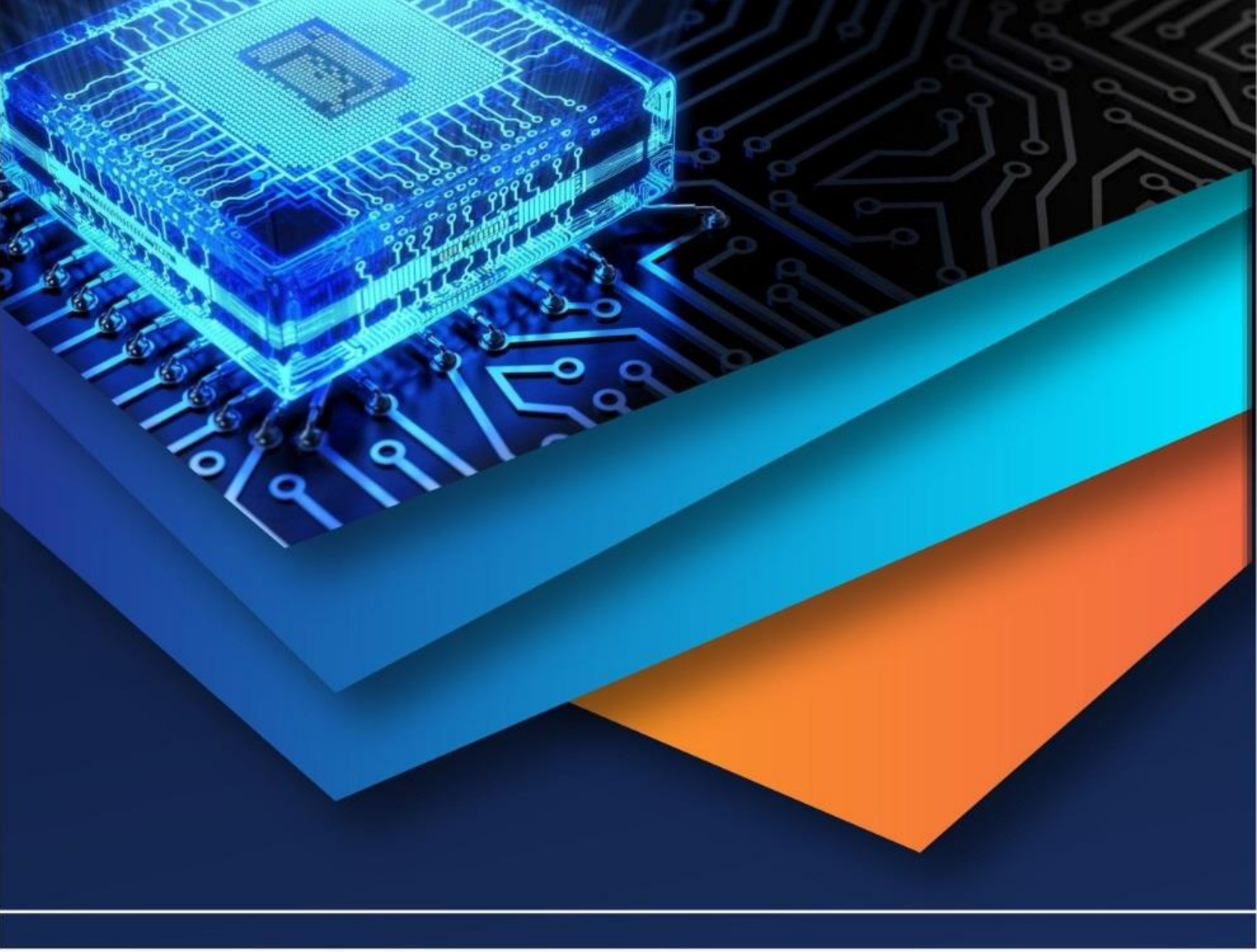
[1] Lokesh Gupta, Ashutosh Patil, Avinash O "A study on the marshall properties of DBM mix prepared using VG-30 and CRMB-55 as binder materials" International Journal of Research in Engineering and Technology, Volume 05 Issue 03, eISSN: 2319-1163, (2016)

[2] Nikhil Saboo, M A reddy and B B Pandey, "Durable wearing course for Bituminous Pavements", Technical Paper, Indian Highways, Page No 14-23, (2014)

[3] Saradarali Mujavar, Dr G Suresh, "Effect of using fillers on laboratory performance studies on bituminous concrete mix prepared using bitumen and modified bitumen", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume 8, Issue 3, Page No 756-761, (2021)

[4] Bereket Admasu Lambebo, "Mix Design for Wearing Course of Flexible Road Pavement by Marshall Method", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume 7, Issue 2, Page No 793-798, (2020)

[5] S.K. Khanna, C.E.G. Justo and A. Veeraragavan, "Highway Materials and Pavement Testing."



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY