



RUTTING PERFORMANCE EVALUATION OF DBM-II BY USING RCRA INSTRUMENT

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Abstract — In India majority of roads are constructed by Flexible pavements. Where in maximum distress is in the form of fatigue cracking or permanent deformation i.e; Rutting. The channelized depression in the wheel path due to heavy repetitive load is called Rutting. In this present work the main task is to find out Optimum Binder Content (OBC) for Dense Bituminous Macadam (DBM) of grade 2 and finding out of Marshall Stability by adding different percentage of plastic waste. By using RCRA instrument Rutting performance of Dense Bituminous Macadam of grade 2 (DBM) and plastic added DBM-2 for pavement temperature 30⁰C, 50⁰C and 70⁰C are find out and compared.

Keywords-component; Job Mix Formula, Dense Bituminous macadam, Optimum Binder Content, Marshall Stability, Roller compactor cum Rut Analyzer

I. INTRODUCTION

Deterioration of road is defined by the damage type of its condition of the road surface over time. There are number of distresses such as cracking, permanent deformation or rutting and disintegration are classified as surface defects.

Rutting is the load induced permanent deformation of bituminous pavements and it can occur in any layer of flexible pavement. Rutting or permanent deformation is one of the common distresses in the flexible pavement which leads to decrease the maintenance cost. Rutting occurs as a sequence of continuous heavy loading which leads to formation of rutting under continuous tire pressure. Due to the continuous application of axle load in the form longitudinal depression across the wheel path, rutting occurs.

II. OBJECTIVE OF THE STUDY

- To conduct the basic test on Materials.
- To find out the Job mix Formula and Optimum Binder Content (OBC) for Dense Bituminous Macadam(DBM) of grade 2
- To find out Marshall Properties like Stability, Flow value, VMA, VFB and Percentage of air voids for conventional and plastic added Dense Bituminous Mix of grade 2.
- To compare the Marshall test results of conventional and plastic added Dense Bituminous mix of grade 2.
- To find out the Rutting performance of conventional dense bituminous mix of grade 2 and plastic added DBM-2 mix for temperature 30⁰C, 50⁰C and 70⁰C.
- To compare the rutting test results between plastic added DBM-2 conventional DBM-2 of pavement temperature 30⁰C, 50⁰C and 70⁰C.

III. LITERATURE REVIEW

Emmanuel G Fenardo, et al^[1] (1984) conducted a study on Rut Susceptibility of Large stone mixtures. In their paper stated that the main issue for the rutting in the asphalt pavement is due to plastic flow and consolidation due to heavy loading. For that they had considerable evidence that a proper design of large stone asphalt paving mixture will give better result compared to conventional mixture.

This research work focused on the following studies.

- 1) To compare the relative creep characteristic in large stone mixtures cores.
- 2) To examine the laboratory compacted large stone asphalt mixtures by using shear tester.

S S Verma^[2] (2008) conducted tests on Roads from Plastic waste. In his works, By using 3-4% of plastic waste with bitumen, melting point of bitumen can be increased which makes the road to be in flexible state. By adding shredded plastic waste to bitumen, the properties of binder can be increased which makes asphalt pavement last long. Marshall Stability value can be increased for BC mix which is of the order 2-3 times greater than conventional mix. Also the prepared mix can withstand the adverse water soaking condition for longer time. This study gives the comparison

between bitumen with plastic and without plastic. With plastic mix gives much higher results that is durability, binding property, higher stability and less maintenance.

Dr K V Krishna Reddy^[3] (2007) conducted test on rutting resistance of filler modified bituminous surface. In his paper an attempt is made by adding crumb rubber, fly ash and lime to study the improvements in rut resistance in flexible pavement. He used laboratory wheel tracking test for the evaluation of rutting resistance in conventional mix and modified mix and also medium scale accelerated pavement rut tester (MAPRT) is used for field test on a circular track.

Nitin Prasad and Nagakumar^[4] conducted experiment on Performance evaluation of dense bituminous macadam mix a refusal density approach. In their journal, they stated about “refusal density” i.e; after compacting a pavement layer by conventional method, due to heavy traffic the pavement layer can further compacted and it reduces the air voids which is called Residual Density. So in their study they conduct experiment for Marshall Stability by using Hugo hammers by varying blows.

Darshna B Joshi et al^[5] conducted tests on finding out of Optimum binder content by Marshall mix design for DBM. Bituminous mix design is done to find out the properties of coarse aggregate, filler and binder materials and also mix should be workable, strong, durable and economical. Aggregate gradation and mix design requirements are primary concern in a asphalt mix. Various volumetric parameter and Marshall Stability is different for different mixes. Material tests should be done to make sure that all material satisfies the Indian standards.

Rema M Devi^[6] (2013) conducted the test on Reduction of OBC in bituminous mixes using plastic coated aggregates. In their paper they stated that plastic road gives more stability and performance than the ordinary roads. Polymer modified bitumen is a good resistance to water which minimize the stripping of bitumen from aggregates.

Ashok Pareek (2012) et al^[7] did their project on Performance of polymer modified bitumen for flexible pavements. In their study, they did experimental study on conventional and polymer modified bitumen and also their research work shows that rutting resistance, indirect tensile strength and resilient modulus of the bituminous concrete mix with polymer modified bitumen is significantly improved.

Hui Wang et al^[8] did their experiment on Investigation of layer contribution to asphalt pavement rutting. In this paper authors investigates on the contributions of structural layer to the total rutting on flexible pavement by taking transverse trenches and cores of selected pavements of expressways. Pavement rutting in china is caused by mainly three asphalt layers over the semi rigid base course. Wearing course get effected by maximum total rutting followed by asphalt surface course and base course. So, it is recommended that pavements with modified binder should be used in the construction of the asphalt intermediate course.

IV. METHODOLOGY

The following steps are adopted for the present study:

- Aggregates, binder and additives are brought from different sources.
- Basic properties of aggregate and binder are find out by conducting suitable test as per codal provision and obtained results are compared with standards.
- Proportioning of mineral aggregates is done for different sources of aggregate as per MoRTH to obtain suitable design mix.
- Then Marshall Stability test is conducted to find out Optimum Binder Content for bituminous mix with plastic and without plastic.
- Rutting test is carried out by using Road Compacting Rut Analyser instrument.

V. LABORATORY INVESTIGATION

Test results for basic properties of materials are as follows:

TABLE 1 PROPERTIES OF COARSE AGGREGATE

SL No	Properties	Obtained results	Limit (as per MoRTH)	Remark
1	Aggregate impact value	14.15%	27%	Satisfactory
2	Crushing value	18.32%	22.4%	Satisfactory
3	Abrasion value	32.96%	35%	Satisfactory
4	Specific Gravity	2.57	2.5-3.0	Satisfactory

5	Water Absorption	0.3	2%	Satisfactory
6	Shape test	19.52	30%	Satisfactory

TABLE 2 PROPERTIES OF BITUMEN

Name of the test	Obtained result	Permissible limit
Penetration test	64.33	60-70
Softening point °C	48	45-55
Flash and fire point °C	278 and 300	175 min
Ductility (mm)	96	75
Specific Gravity	1.00	0.99

TABLE 3 MARSHALL TEST RESULTS FOR DBM-2

% of Bitumen	Unit weight (g/cc)	Stability (kg)	Flow value	Vv (%)	VMA (%)	VFB (%)
4	2.226	941.68	3.07	7.3	16.48	55.70
4.5	2.259	1029.15	3.5	4.36	15.24	68.79
5	2.277	1150.89	3.87	2.85	14.58	80.47
5.5	2.259	1251.92	4.33	2.45	15.25	83.97
6	2.252	1006.48	4.5	1.56	15.49	89.95

TABLE 4 MARSHALL TEST RESULTS FOR PLASTIC DBM-2 FOR OBC WITH VARYING PERCENTAGE OF PLASTIC WASTE

% of Plastic	Unit weight (g/cc)	Stability (kg)	Flow value	Vv (%)	VMA (%)	VFB (%)
6	2.187	1438	3.2	8.71	19.44	55.20
7	2.212	1578	3.45	6.46	17.32	62.7
8	2.212	1760	3.8	5.26	16.12	67.3
9	2.207	1610	4.1	4.31	15.14	71.57
10	2.203	1598	4.4	3.27	14.08	76.5

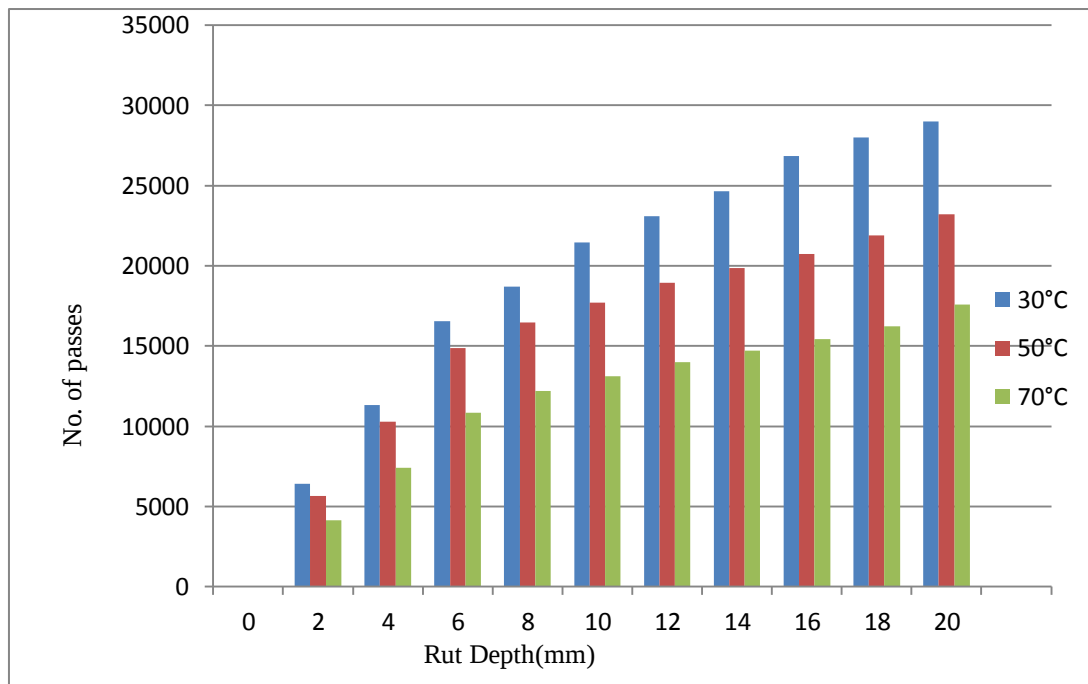
TABLE 5 RUTTING TEST RESULTS FOR DBM-2 OF VG-30 AT 30⁰C

Rut Depth in mm	Number of Passes required for DBM-2 of VG-30 at		
	30°C	50°C	70°C
0	0	0	0
-2	6426	5656	4156
-4	11322	10298	7421
-6	16563	14873	10853
-8	18696	16466	12217
-10	20085	17692	13108
-12	21465	18931	14003
-14	22584	19879	14707
-16	23109	20728	15426
-18	24701	21886	16235
-20	26693	23231	17581

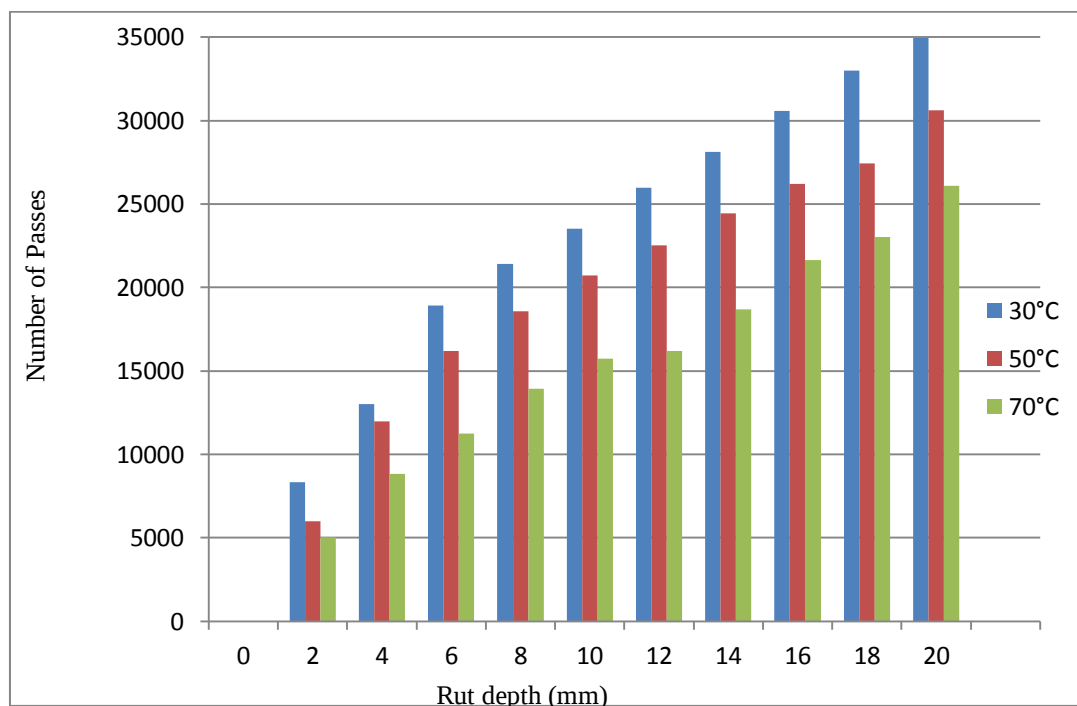
TABLE 6 RUTTING TEST RESULTS FOR PLASTIC ADDED DBM-2 OF VG-30 AT 30⁰C

Rut Depth in mm	Number of Passes required for DBM-2 of VG-30 at		
	30°C	50°C	70°C
0	0	0	0
-2	8340	6004	5019
-4	13006	11986	8827
-6	18918	16190	11234
-8	21401	18571	13950
-10	23510	20712	15719
-12	25984	22531	16194
-14	28117	24463	18707
-16	30574	26208	21650
-18	33006	27423	23023
-20	34965	30610	26101

GRAPH 1 COMPARISON OF RUTTING TEST RESULTS FOR PAVEMENT TEMPERATURE 30⁰C, 50⁰C AND 70⁰C OF VG-30 OF DBM-2



Graph 2 Graph showing Comparison of rutting test result of 8% plastic added DBM-2 for 30⁰C, 50⁰C and 70⁰C



VI. CONCLUSION

Following conclusions are drawn on the basis of laboratory investigation.

1. Basic properties of Coarse aggregates, Bitumen and Bituminous Binder are tested and the materials satisfies the Standard Specifications of MoRTH (5th revision).
2. The Job Mix Formulae is done meeting the desired gradation of MoRTH and the Optimum Binder Content (OBC) for DBM Grade-II Mix is 5.1%
3. Marshall Test Properties like Stability, flow value, Volume of voids, VMA, and VFB for conventional mix of DBM-II are 1235.14 Kg, 3.93mm, 5.54%, 16.96% and 67.33% respectively and for 8% of plastic added DBM-II are 1760Kg, 3.8mm, 5.26%, 16.12% and 67.3% respectively.
4. Stability of 8% plastic added mix is approximately 40% greater than conventional mix. Volume of voids decreased by 3.84% and flow value decreased by 3.3% in Plastic added DBM-2 mix.
5. From test results it is observed that for 10mm rut depth the number of passes for conventional DBM-2 mix at 30⁰C, 50⁰C and 70⁰C are 21458, 17692 and 13108 respectively and for 20mm rut depth 29002, 23231 and 17581 respectively.
 - a. From the test results it is observed that for 10mm rut depth, the conventional pavement sustain 35% more number of passes at 50⁰C Compared with 70⁰ c and 24% more number of passes at 30⁰C when compared with 50⁰C
 - b. Similarly for 20mm rut depth, the conventional pavement sustain 32% more number of passes at 50⁰C Compared with 70⁰C and 25% more number of passes at 30⁰C when compared with 50⁰C
6. From test results it is observed that for 10mm rut depth the number of passes for 8% plastic added DBM-2 mix at 30⁰C, 50⁰C and 70⁰C are 23510, 20712 and 15719 respectively and for 20mm rut depth 34965, 30610 and 26101 respectively.
 - a. From the test results it is observed that for 10mm rut depth 8% plastic added DBM-2 pavement sustain 35% more number of passes at 50⁰C Compared with 70⁰ c and 24% more number of passes at 30⁰C when compared with 50⁰C
 - b. Similarly for 20mm rut depth, 8% plastic added DBM-2 pavement sustain 32% more number of passes at 50⁰C Compared with 70⁰C and 25% more number of passes at 30⁰C when compared with 50⁰C

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1. Road compactor Rut Analyzer (RCRA) Instrument



2. Before Rutting Test



3. After Rutting Test



4. Marshall Specimens