Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 10, October-2017

PERFORMANCE EVALUATION OF BITUMINOUS CONCRETE USING RCRA

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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 Bituminous concrete (BC) of grade 2 and finding out of Marshall Stability by adding different percentage of plastic waste. By using RCRA instrument Rutting performance of Bituminous concrete (BC) of grade 2 and plastic added BC-2 for pavement temperature 30^0C, 50^0C and 70^0C are find out and compared.***

Keywords-component; *Job Mix Formula, Bituminous concrete, 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 tests on Materials, to find out the Job Mix Formula and Optimum Binder Content for BC-II.*
- *To find out Marshall properties i,e; Stability, Flow value, VFB, VMA, Percentage of voids for conventional and plastic added BC-II.*
- *To compare the Marshall test results of conventional and plastic added BC-II mix.*
- *To find out and compare the Rutting performance of conventional BC-II and plastic added BC-II mix for temperature 30^0C, 50^0C and 70^0C.*

III. LITERATURE REVIEW

Miss Apurva J Chavan[(1)] (2013) In her paper she concluded that use of Plastic as a coating on Aggregate which gives better binding property and gives better road performance. It reduces the voids between aggregate and bitumen. It helps in preventing Stripping. In her paper results shows that use of plastic gives better performance than plain bitumen by various experiments.

Savita Devi [(2)] (2008) Objective of this research project is to utilize waste plastic as useful binding material. This study will determine the increase of plastic waste in Bitumen enhances the Aggregate property and the Bitumen property. This researches focus on the replacing of bitumen by waste plastic. Experiments were made by cylindrical moulds and cylindrical moulds were prepared by replacing Bitumen by 5%, 7.5%, 10% & 12.5% of Waste Plastics and Mix design were made. And Bitumen is taken by 4.5%, 5%, 5.5% & 6% of total weight of aggregate. Result indicates that the Optimum use of plastic can be 7.5% and 6% of Bitumen which gives more stability based on Marshall Stability Test.

Avula Vamshi[(3)] (2007) In his paper he has discussed about plastic waste such as carry bags, cup and other waste plastic which can be used as a effective coating over aggregate and it has good binder property for bitumen which can be used for road construction. As road is subjected to different climatic conditions, bitumen starts bleeding in hot climate, cracks are developed during cold climate and damage occurs due to heavy loads. So in his experiment he replaced bitumen by plastic wastes which shows better binding property.

Audrius Vaitkus [(4)] In this research paper the author did the analysis on the resistance to the rutting of an asphalt pavement and has been tried to find out the variation of rut depth independent of traffic loading [ESAL'S].

The experiment conducted in a street of Vilnius city, the author performed the experiment in 27 different pavement structures with 23 sectors of 30m long and 20m long.

Hui wang [(5)] In this paper the author analyzed the contribution of the structural layer to the overall rutting in the Asphaltic pavement with semi rigid base. The author did an in situ experiment by executing transverse trenches in one of the express highway of china. In this investigation they selected a site such that it consists of 3 layers .i.e., Base course, Intermediate course and Surface course. The semi rigid base consists of 20cm and 36cm thick of sub base course. The collected sample specimen is cut into 300mm*150mm of standard size and placed in a rutting testing specimen of size 300mm*300mm standard mould..Dynamic Stability (DS) is the parameter used in laboratory for rutting test.

Mostafer.A.Elseifi, M.ASCE [(6)] In their paper they used Asphalt Shingle which is recycled for flexible pavements. The main objective of the paper is to study the effect of adding recycled Asphalt Shingle (RAS) on the binder rutting and fatigue using Wet process and it is investigated by multiple stress creep recovery (MSCR) and the Linear amplitude sweep (LAS) and also in laboratory investigation. They made various experimental programs and obtained various results. Results of LAS test shows with the increase of RAS improves the resistance to cracking obtained by fatigue, SCB test shows that use of RAS decrease in fracture resistance of the mix. So finally they concluded that use of RAS improves the resistance to fatigue cracking and fracture resistance of mix.

Ashok Pareek (2012) et el[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.

Dr. K V Krishna Reddy [(8)] Chilkur balaji institute of technology (CBIT),2007. 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.

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
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	35%	Satisfactory

TABLE 2 PROPERTIES OF BITUMEN

Name of the test	Obtained result	Permissible limit
Penetration test	64.33	40-100
Softening point ^{0}C	48	35-70
Flash and fire point ^{0}C	276 and 300	220 min
Ductility (mm)	96	50
Specific Gravity	1.00	0.97-1.02

TABLE 3 MARSHALL TEST RESULTS FOR DBM-2

% of Bitumen	Unit weight (g/cc)	Stability (kg)	Flow value	Vv (%)	VMA (%)	VFB (%)
4.5	2.28	1180.42	3.1	5.26	15.52	66.10
5	2.295	1212.45	3.4	3.92	15.40	74.55
5.5	2.315	1243.57	3.8	2.46	15.19	83.80
6	2.33	1269.23	4.1	0.85	14.83	94.26
6.5	2..32	1229.20	3.6	0.64	15.72	95.92

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	2.3	1260	3.2	4.35	17.32	74.88
7	2.31	1422	3.4	3.24	16.26	80.07
8	2.34	1510	3.7	5.26	18.49	71.5
9	2.32	1492	4.0	4.31	17.39	75.21
10	2.3	1465	4.2	3.27	16.24	79.86

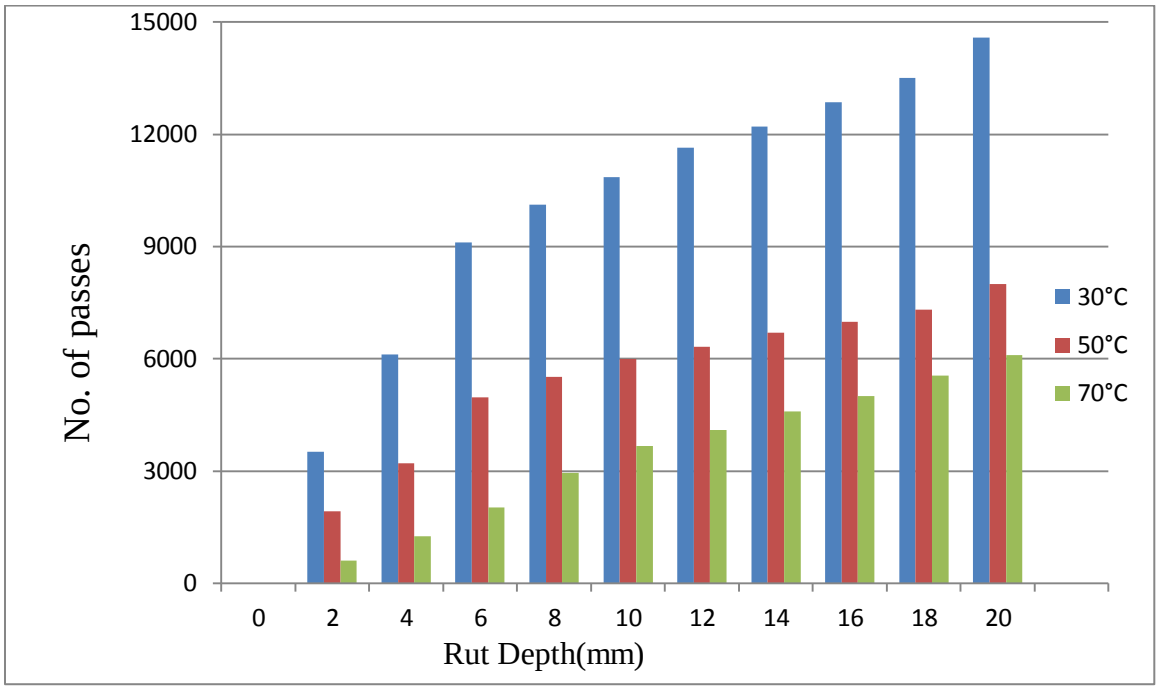
TABLE 5 RUTTING TEST RESULTS FOR BC-2 OF VG-30 AT 30^0C

Rut Depth in mm	Number of Passes required for BC-2 of VG-30 at		
	30°C	50°C	70°C
0	0	0	0
-2	3516	1919	601
-4	6110	3212	1250
-6	9102	4965	2020
-8	10125	5516	2952
-10	10850	5994	3665
-12	11650	6315	4094
-14	12205	6691	4585
-16	12851	6997	5001
-18	13498	7321	5550
-20	14590	7993	6091

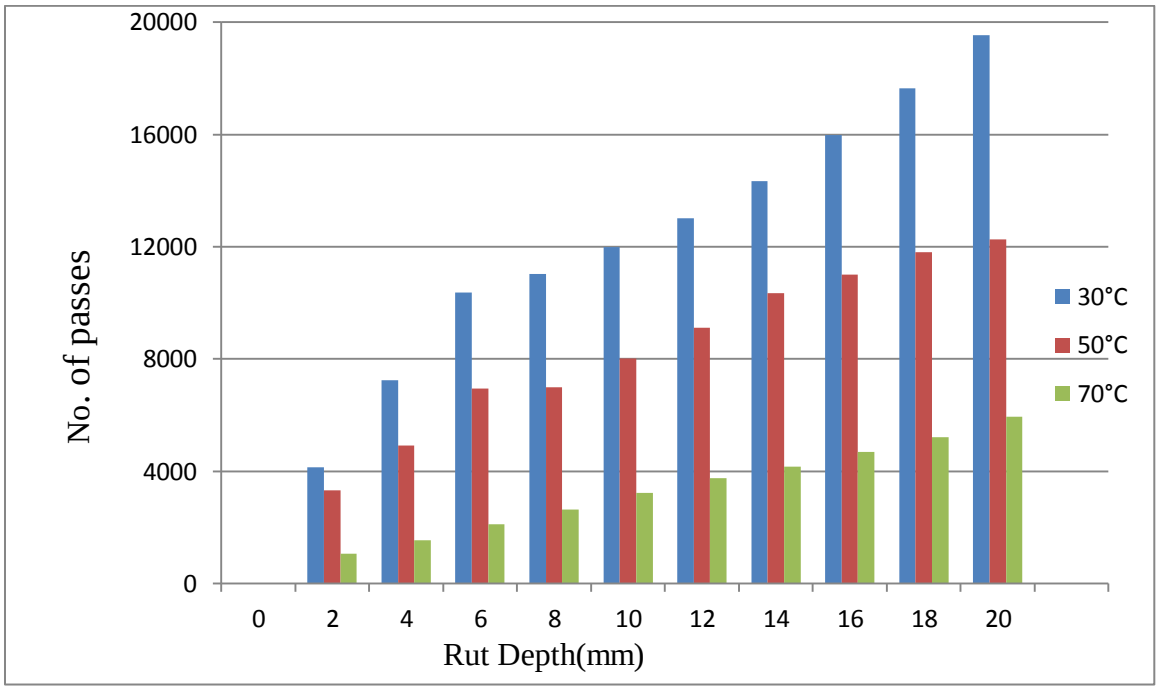
TABLE 6 RUTTING TEST RESULTS FOR PLASTIC ADDED BC-2 OF VG-30 AT 30^0C

Rut Depth in mm	Number of Passes required for BC-2 of VG-30 at		
	30°C	50°C	70°C
0	0	0	0
-2	4151	3310	1059
-4	7248	4918	1549
-6	10364	6951	2099
-8	11029	7002	3041
-10	11997	8016	4218
-12	13010	9124	5054
-14	14341	10354	5859
-16	15982	11009	6691
-18	17654	11802	7215
-20	19531	12251	8940

GRAPH 1 COMPARISON OF RUTTING TEST RESULTS FOR PAVEMENT TEMPERATURE 30^0C, 50^0C AND 70^0C OF VG-30OF BC-2



Graph 2 Graph showing Comparison of rutting test result of 8% plastic added BC-2 for 30^0C, 50^0C and 70^0C



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 and Job Mix Formula is done meeting the desired gradation of MoRTH and the Optimum Binder Content(OBC) for BC Grade-II Mix is 5.64%
2. Marshall Test Properties like Stability, flow value, Volume of voids, VMA, and VFB for conventional mix of BC-II are 1251.14 Kg, 3.91mm, 3.71%, 16.77% and 77.87% respectively and for 8% of plastic added BC-II are 1510Kg, 3.7mm, 5.26%, 18.46% and 71.5% respectively.
3. Stability of 8% plastic added mix is approximately 21% greater than conventional mix.
4. From test results it is observed that for 10mm rut depth the number of passes for conventional BC-2 mix at 30^0C, 50^0C and 70^0C are 10850, 5994 and 3665 respectively and for 20mm rut depth 14590, 7993 and 6091 respectively.
    A. From the test results it is observed that for 10mm rut depth, the conventional pavement sustain 64% more number of passes at 50^0C Compared with 70^0 c and 81% more number of passes at 30^0C when compared with 50^0C
    B. Similarly for 20mm rut depth, the conventional pavement sustain 31% more number of passes at 50^0C Compared with 70^0C and 83% more number of passes at 30^0C when compared with 50^0C
5. From test results it is observed that for 10mm rut depth the number of passes for 8% plastic added BC-2 mix at 30^0C, 50^0C and 70^0C are 11997, 8016 and 4218 respectively and for 20mm rut depth 19531, 12251 and 8940 respectively.
    A. From the test results it is observed that for 10mm rut depth 8% plastic added BC-2 pavement sustain 90% more number of passes at 50^0C Compared with 70^0 c and 50% more number of passes at 30^0C when compared with 50^0C.
    B. Similarly for 20mm rut depth, 8% plastic added BC-2 pavement sustain 37% more number of passes at 50^0C Compared with 70^0C and 59% more number of passes at 30^0C when compared with 50^0C.

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1. Roller compaction Rut Analyzer (RCRA) Instrument

2. Before Rutting Test

3. After Rutting Test

4. Marshall Specimens