IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 5, May 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Rutting Behaviour of Polymer Modified Bituminous Concrete by Using Waste Plastic

Rohit Jain[1], Sourabh Gupta[2] and H.S. Goliya[3]

[1] Civil Engineering, SGS Institute of Technology and Science, Indore, Madhya Pradesh, 452003, India

[2] Civil Engineering, SGS Institute of Technology and Science, Indore, Madhya Pradesh, 452003, India

[3] Civil Engineering, SGS Institute of Technology and Science, Indore, Madhya Pradesh, 452003, India

Abstract

Now days traffic is increasing at faster rate on roads due to which various type of defects are produced like rutting, fatigue etc. The utilization of waste material like waste plastic, crumb rubber, jute fiber is increasing. Rutting is one of the major distresses in flexible pavement. Rutting is defined as surface distress due to load along longitudinal direction. In this study, Waste Plastic has been used as an additive in the bituminous concrete to reduce the rutting defect in flexible pavement. Wheel Tracking Equipment has been used to study the rutting defect due to the movement of heavy load wheel assembly on the specimen prepared.

Keywords: *Rutting, MoRT&H, Dry Process, Wet Process, OBC, OPC.*

1. Introduction

Bitumen has been widely used in India and all over the world for the construction of flexible pavements for more than 100 years. Flexible pavements with bituminous surfacing are widely used in India and all over the world. Continuous growth of infrastructure in road construction work needs natural resources. In recent times utilization of natural resources and encouragement for using waste product like waste plastic, crumb rubber and jute fiber in road construction is increasing. Rutting is one of the major distresses in flexible pavement. At the present time, Ministry of Road Transport & Highways (MoRT&H) Specification for Road and Bridge Works, latest edition is used for construction of all roads including national highways and state highways. Advances in bituminous construction technologies which involve waste materials like plastics, jute, rubber etc. for improvement in road are made in the world every year. Now days in India nearly more than 15 million tons of plastics are used. There visibility has not been ignored as a dangerous problem and made plastic a target in the management of solid waste. They also have a long lifetime and burning of various forms of plastics under uncontrolled conditions could also lead to production of many hazardous air pollutants depending upon the different type of polymers and additives used. Rutting is defined as surface distress due to load along longitudinal direction.

Fig. 1 Measurement of Rutting

In order to reduce these problems like rutting and many others, there is a need to shift the focus from normal bituminous mixes to modified bituminous mixes. The

modified bituminous mixes are better than normal bituminous mixes in many ways. The design life of roads which is made by modified bituminous mixes is far better than normal bituminous mixes. The use of waste plastic in bituminous concrete or asphalt mix has proved a most economical and efficient solution to meet the problem of rutting defect.

The study was performed to investigate the performance behavior of bituminous concrete and its characteristic comparison with plain bituminous mix used in flexible pavement. Samples of bituminous concrete mix were prepared with and without waste plastic and were tested for mechanical properties along with properties like rutting. The optimum dosage of waste plastic was found to be 4%, 7% and 10% in different grading and different process (Dry Process & Wet Process) considering economy and performance as the most crucial factor for designing with an optimum binder content of 5.49% for Grading I in bituminous concrete layer.

2. Experimental Details

Considering reduction of rutting using waste plastic as an aim to achieve, Marshall Test and Rut Test were carried out to compare the stability and rut depth of Bituminous Concrete Mix (with and without waste plastic). Samples were prepared to evaluate various performance tests.

2.1 Marshal Test

The Marshall Test was carried out with or without waste plastic in sample preparation. The study was done on Bituminous Concrete (BC) mixes using VG30 grade bitumen having maximum stability was 14.20 KN at optimum bitumen content 5.49% by weight of total mix. The waste plastic was added in mixes in different proportions i.e. 4%, 7% and 10% by weight of bitumen for both process (Dry and Wet Process). The Stability is increased with increasing the content of waste plastic up to particular per cent of waste plastic then decreases in grading I. Hence stability was considered as criteria for adopting the optimum content. Table 1 shows relation between stability and percent waste plastic.

Table 1: Maximum stability at different plastic content

% Plastic By Weight Of Binder	Maximum Stability for grading I	
	Wet process	Dry process
0%	14.12	14.12
4%	17.77	16.11
7%	18.11	17.32
10%	18.88	14.49

Hence 10% for wet process and 7% for dry process of waste plastic by weight of bitumen in grading (I) were considered as the optimum value for further study. The rut depth of different mixes at varying temperature is found out.

2.2 Wheel Rut Tester

Wheel track rutting Test is applied to determine the resistance of bituminous concrete mixtures against permanent deformation at critical temperatures (40°C, 50°C and 60°C) and under loading similar to what the pavement surface is applied. This test can be done on the cylindrical kernels taken from the asphalt road as well as asphalt slab made in the laboratory. Wheel track rutting test with the reciprocating motion of loaded wheel on asphalt specimens determine the potential of asphalt pavement rutting. This is done by measuring the rut depth created in the sample along the moving of apparatus's

wheel at specified intervals by rut gauge. Desired rut-gauges should have sufficient accuracy at least 0.1 mm. The maximum rut depth measured by wheel track apparatus is 20 mm and then the machine turns off. The depth of impression (or deformation) was recorded by machine in mm. The slabs are compacted with wheel shaper compression machine and then tested at three different temperatures 40°C, 50°C & 60°C and deformations at 500, 1000, 1500, 2000 and 2500 were noted and shown in below figures.

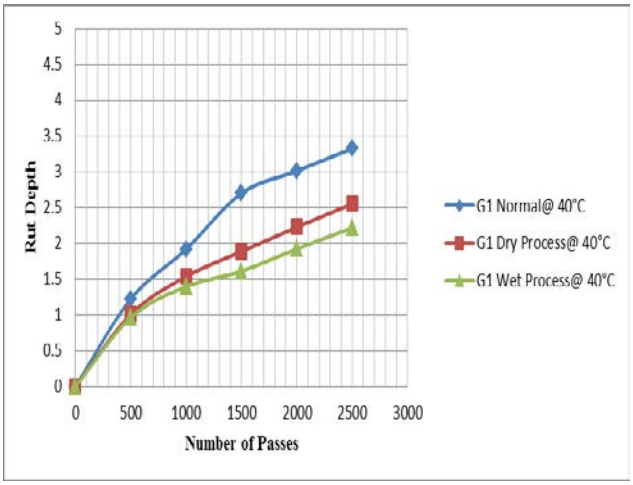

Fig. 2 Rut Depth Vs Number of Passes Curve for Grading I @ 40°C

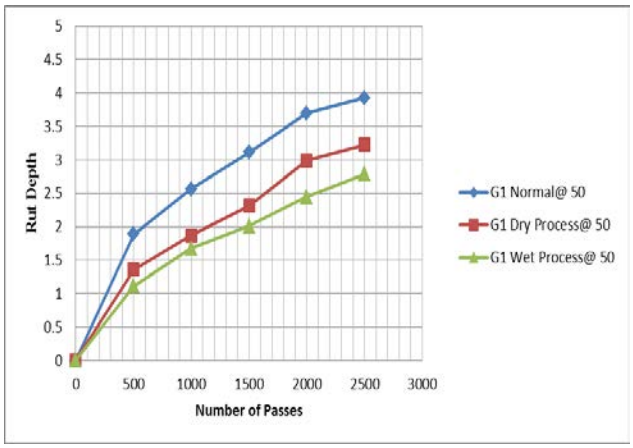

Fig. 3 Rut Depth Vs Number of Passes Curve for Grading I @ 50°C

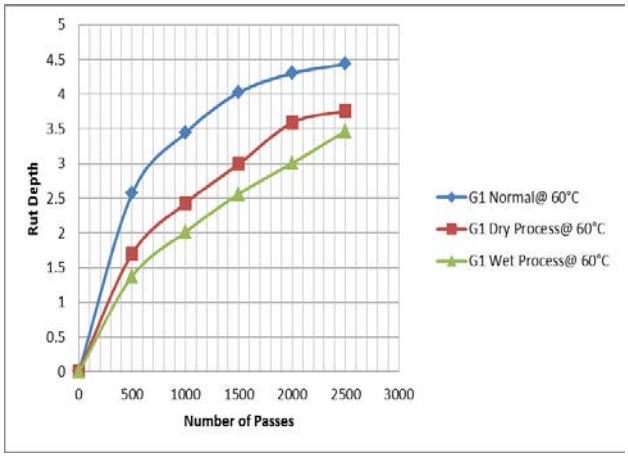

Fig. 4 Rut Depth Vs Number of Passes Curve for Grading I @ 60°C

3. Results and Discussions

The discussions of result are described below:

- The optimum binder content of VG 30 plain bituminous concrete (BC) Grading I was found to be 5.493%, whereas the OBC for PMBM (dry process) Grading I with 7% waste plastic was found to be 5.54%.
- In wet process the optimum binder content with 10% of waste plastic was found to be 5.47% for Grading I.
- The Marshall Stability of normal bituminous concrete mix was found to be 14.12 KN for Grading I.
- The Waste Plastic (7% of bitumen binder) was used in bituminous concrete mix (Grading I) by dry process. The Marshall Stability was found to be 17.22 KN.
- Use of 10% of Waste Plastic in Modified mix by wet process in Grading I. The Marshall Stability was found to be 18.88 KN.
- The rut depth of VG 30 plain bituminous concrete at 40°C, 50°C and 60°C was found to be

3.325mm, 3.391mm and 4.433mm respectively at 2500 no. of passes for Grading I.

- The rut depth of PMBM with 7% waste plastic by dry process at 40°C, 50°C and 60°C was found to be 2.551mm, 3.229mm and 3.761mm respectively at 2500 no. of passes for grading I.
- The rut depth of PMBM with 10% waste plastic by wet process at 40°C, 50°C and 60°C was found to be 2.218mm, 2.789mm and 3.467mm respectively at 2500 no. of passes for grading I.

4. Conclusions

- The Stability in case of Dry Process increased to 14.70% on addition of plastic up to 7% and further addition of plastic waste leads to decrement in stability values, similarly in case of wet process it is 22.01% on addition of plastic up to 10% then on further addition of plastic waste stability decreases. Thus, the wet process of polymer modification gives improved bituminous mix (grading I) as compare to dry process.
- The Rut Depth of Polymer Modified Bituminous Mix by Dry Process at the temperature of 40°C, 50°C and 60°C was found to be decreased 23.27%, 17.85%, and 15.15% respectively as compare with normal bituminous mix for Grading I. Thus the minimum rut depth was found at 40°C.
- The Rut Depth of Modified Mix (Wet Process) for Grading I at the temperature of 40°C, 50°C, and 60°C was found to be decreased 33.29%, 29.05% and 21.79% respectively as compare with normal bituminous mix. Thus the minimum rut depth was found at 40°C.
- The Rut Depth of Polymer Modified Bituminous Mix by Wet Process at the temperature of 40°C, 50°C and 60°C was found to be decreased 10.11%, 11.20%, and 6.64% respectively as compare with Dry Process for Grading I. Thus the minimum rut depth was found at 50°C.
- The Rut Depth of Modified Mix (Wet Process) for Grading II at the temperature of 40°C, 50°C, and 60°C was found to be decreased 8.94%, 11.06% and 3.9% as compare with Dry Process. Thus the minimum rut depth was found at 50°C.
- Results showed that the wet process is more effective in reducing rutting for grading (I) at 40°C.

References

[1] IRC; Special Publications-53: (2002), “Tentative Guidelines On Use Of Polymer and Rubber Modified Bitumen in Road Construction”.
[2] Williams, S.G., (2003), “The Effects of HMA Mixture Characteristics on Rutting Susceptibility”, paper Prepared for Publication and Presentation at the 2003 Annual Meeting of the Transportation Research Board Revised November 2002, 1-15.
[3] Pareek, A., et al., (2012), “Performance of PMB for flexible pavement”, International Journal Structure & Civil Engineering Research, 77-86.
[4] Kumar, K., and Kumar, G., (2013), “Rutting Characteristics of 40 Mm Thick Bituminous concrete Mix with Plain and Modified Binders at Varying Temperatures Using Treaded Wheel”, IRC 2013, 16-25.
[5] Ministry of road transport and highways. (MoRTH). (20013). “Specifications for road and bridge works”, 5th Rev. Indian Road Congress. 155-158