Migration Letters

Volume: 20, No: S6(2023), pp. 823-827

ISSN: 1741-8984 (Print) ISSN: 1741-8992 (Online)
www.migrationletters.com

Rutting Resistance of full depth Asphalt Pavement Structure

Hawraa M. jaffer[1], Hasan H. Joni[2], Rasha H. Al-Rubaee[3]

Abstract

Asphalt roads that have been permanently deformed have a negative effect on their performance. The pavement's service life is shortened and dangers to motorists and pedestrians are increased when rusting occurs. defects in the pavement, such as rutting and fatigue, The ability of an asphalt pavement structure to withstand rutting depends on the high-temperature properties of the asphalt mixture, as well as the pavement's structure and thickness. In this study, a full-depth wheel tracking test is utilized to examine the effects of full-depth asphalt layers and the addition of RAP on rutting resistance by implementing models of two layers of full-depth asphalt pavement structure (surface, base) layer with 30% RAP, This paper's findings shown that asphalt mixtures including RAP can achieve high levels of rutting performance of full-depth by using model with a dimension (30cm 30cm * 15cm). According to the findings, recycled asphalt pavement performs better than the original. It can be noticed that at an optimum value of about 30% RAP will reduce the rutting depth by (60%), at temperatures of 60 °C.*

Keywords: *Full depth, Asphalt Mixture, Rutting, RAP.*

1. Introduction

Reclaimed asphalt pavement or RAP, is made from recycled asphalt that was previously used for another purpose. When utilized as supplemental hot recycling or cold recycling aggregate, it is a byproduct of pavement repair and rehabilitation that is occasionally employed as the asphalt course base subbase course of a new pavement [1]. More and more recycled asphalt pavement (RAP) is being used in asphalt pavement mixtures since doing so saves money and protects natural resources by decreasing the need for new virgin ingredients (aggregate and asphalt binder). However, the cost of disposing of old pavement trash is decreased when RAP is used in Hot Mix Asphalt (HMA). RAP's incorporation into HMA has spread rapidly in recent years due to the aforementioned reasons. Much research in the literature evaluated the mechanical characteristics and performance of HMA mixed with RAP. The benefits and drawbacks of using RAP in HMA have been studied, and the best recycling ratios have been analyzed [2]. Asphalt pavements are prone to rutting, which is a significant type of hardship, particularly in hot, tropical climates and throughout the summer in temperate countries. Rutting results from the development of permanent or irreversible distortion in all pavement layers as a result of frequent traffic stress. The accumulated permanent deformation in the surface course of asphalt pavement is recognized to be the primary contributor to the ultimate rut depth measured on the pavement surface among the contributions of rut depth by the various

[1] Highways and Bridges Engineering Branch, Civil Engineering Department, University of Technology, Baghdad, Iraq, bce.21.37@grad.uotechnology.edu.iq
[2] Highways and Bridges Engineering Branch, Civil Engineering Department, University of Technology, Baghdad, Iraq, 40317@uotechnology.edu.iq
[3] Highways and Bridges Engineering Branch, Civil Engineering Department, University of Technology, Baghdad, Iraq, 40323@uotechnology.edu.iq

pavement layers. Therefore, rutting resistance is a crucial factor in the construction of asphalt mixes using industry standards (Asphalt Institute, 1997) [3]. In order to replace some of the mineral filler or asphalt, RAP has been blended with asphalt. According to research, these combinations are more resistant to rutting than the control asphalt Coleri and others. observed that the aggregates interlock more effectively, leading to higher shear resistance and high-temperature performance in asphalt pavements with dense gradation and large aggregate size. [4] It can be difficult to increase the middle layer's rutting resistance, nevertheless, because the asphalt mixture also takes the middle-layer mixes' moisture sensitivity and low-temperature crack resistance into account. Additionally, it has been demonstrated in a prior study that the lower-layer mixtures in asphalt pavements primarily give resistance to fatigue cracking; as a result, the lower-layer mixtures should have strong crack resistance [5]. The increased rutting or decreased fatigue life of flexible pavements could be attributed to errors in flexible pavement analysis and a disregard for whether pavement components form a balanced section with equal rutting and fatigue lifetimes [6]. Different effects apply to dynamic axle loads compared to static axle loads or axle loads recorded while the vehicle is stopped at a truck inspection station. Caused by the cars' axles and frames being activated by the dynamic interaction between the pavement and the vehicles.

[7]. The goal of this work is to study what occurs to full-depth paving layers when a RAP is added.

2. Aim of the Study

The major objective is to assess the efficacy of adding some reclaimed asphalt pavement as waste material to hot asphalt mixes in order to ascertain whether they are suitable for local conditions and improve overall functionality and rutting performance.

3. Experimental Work

3.1 Materials

For the Full depth asphalt layer (surface, base layer) the al-Nibaei quarry supplied the aggregate as well. The properties and gradation of the aggregates are displayed in Tables (1 and 2). AC (40-50) asphalt from the Daurah refinery in Baghdad city was the only kind of asphalt used. As shown in Table(3), several physical characteristics tests were performed.

Table 1. The characteristics of aggregates

The Property	ASTM Designation	Coarse aggregate	Fine aggregate	Specification
Bulk Specific Gravity	C127, C128	2.628	2.569	-
Apparent specific gravity	C127, C128	2.615	2.627	-
Percent Water Absorption	C127, C128	0.94	0.92	-
Angularity	D 5821	95 %	-	Min 90 %
Toughness, by (Los Angeles Abrasion)	C535	20.2%	-	Max. 30%
Soundness	C88	3.9 %	-	Max 12 %

Table 2. Gradation Of the Aggregate Using In Asphalt Mixture For Wearing and Base Course

Sieve size (in),(mm)	**surface course**		**base course**	
	Specification limit (SCRB 2003/R9)	**Passing (%)**	**Specification limit (SCRB 2003/R9)**	**Passing (**
3/4" (19 mm)	**100**	**100**	**90-76**	**83**
1/2" (12.5 mm)	**100-90**	**95**	**80-56**	**68**
3/8" (9.5 mm)	**90-76**	**83**	**74-48**	**58**
No.4 (4.75 mm)	**74-44**	**59**	**59-29**	**43**
No.8 (2.36 mm)	**58-28**	**43**	**45-19**	**32**
No.50	**21-5**	**13**	**17-5**	**11**
No.200 (0.075 mm)	**10-4**	**7**	**8-2**	**5**

Table 3. Physical properties of bitumen

Property	Value	ASTM Designation
Penetration at 25°C (0.1 mm)	**46**	(ASTM-D5, 2012)
Viscosity at 135°C(cp)	**612**	(ASTM-D4402, 2012)
Viscosity at 165°C(cp)	**155**	(ASTM-D4402, 2012)
Softening point °C	**52**	(ASTM-D36, 2012)
Specific gravity	**1.04**	(ASTM-D70, 2010)

 RAP was brought from a road in Baghdad's Al-Qadisiyah neighborhood. The stated road's pavement was taken off to a depth of 5 cm. RAP has an average asphalt concentration of 4.6%, according to an extraction test per ASTM D-2172.

3.2 Pavement layer preparation

According to the Marshall technique, the surface's courses and base optimal asphalt contents are respectively 5% and 3.5%, depending on the mixture's mechanical qualities. 30% Rap was shown to offer the best attributes from the standpoint of (stability, flow, and air voids).

3.3 Testing for Permanent Deformation in Wheel Tracking

Rutting is a common problem with flexible pavements, especially in the summer when pressure, axle loads, and temperature all rise. The asphalt mixing plates in this experiment were compacted using roller compacting equipment. A binder percentage of (18-22%) of the air content at 60 °C was For each kind of combination, it was discovered to be best for compacting plates of 300 x 400 x 50 mm.

3.4 Preparation of asphalt concrete mixture

The roller compactor apparatus was used to compact the asphalt slabs for wearing coarse and base coarse asphalt concrete mixtures. All slab specimens were prepared in this work to be tested and they all achieved the required density and thickness of (5) cm for wearing a coarse layer, and (10) cm for base a coarse which corresponded to the density and thickness obtained using the roller compactor machine that was used on the construction sites for pavement construction. An asphaltic material slab is compacted with the help of a roller compactor, which is operated by pneumatics and is used to test the materials. in-situ compaction model. According to (AASHTO: T 312- 2010), (BS EN 12697 - 33, 2003), and (shell bitumen handbook), compacted asphalt slab specimens created 4 percent of air spaces.

According to (BS EN 12697 - 22, 2003), the compacted slab specimens utilized in this work had dimensions of (30cm* 30cm* 5cm) to imitate the wearing coarse layer dimension and (30cm* 30cm* 10cm) for foundation course two slabs. Placed in a mixing bowl after the aggregates have been prepared to the proper mixing temperature is the asphalt binder, which has also been heated to the proper mixing temperature. A heated plate should be used to physically mix the asphalt and aggregates for several minutes

until the asphalt has thoroughly covered the aggregate and a homogenous mixture has been produced. According to (Asphalt Institute, 2015), the asphaltic concrete mixtures were then exposed to short-term aging of compaction for 4 hours at 135°C. The mixtures are then compacted using a Roller Compactor in compliance with the specifications (EN 12697-part 33: 2003). A force of 7–10 kN is used to sufficiently crush the material while maintaining the permitted air gaps. preparing slab specimens are shown in Figure (1).

Figure (1): Prepare Slab Specimens

4. Results and Discussion

It is irrational to suppose that the rutting performance of a pavement was determined by a single layer of asphalt mixture. The design of the asphalt pavement structure can be improved using the full-depth structure dynamic stability Material characteristics including stiffness, fatigue resistance, and resistance to permanent deformation have an impact on each layer's resistance to rutting. To handle the weight of vehicles over time, surface layers are often constructed to be stiffer and to have greater rutting resistance. Figure (2) show that when 30% RAP is added to the hot recycling mix model, the rut depth is less than in the hot asphalt mix (HMA) model at (60ºC). This is because mixtures with RAP have greater stiffness than those without RAP. This agrees with the findings of [8].

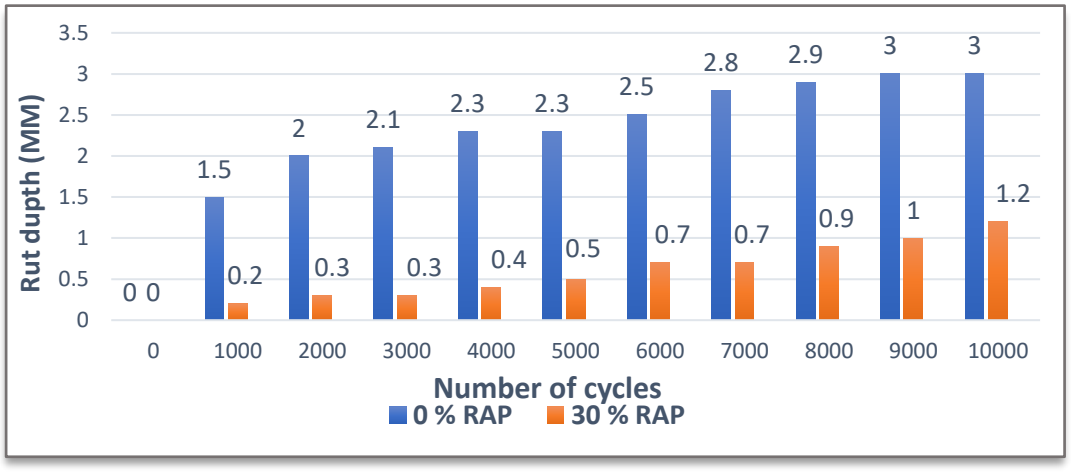

Figure (2): Influence of RAP Content on the Rut Depth of full-depth asphalt layer at (60ºC)

5. Conclusions

Increasing the performance of the asphalt mixture in the middle layer of an asphalt pavement is the most effective way to make the pavement less susceptible to rutting. The wheel track test findings at (60ºC) demonstrate that the reduced rut depth values acquired

for 30% RAP and control asphalt mixtures were (1.2 and 3), respectively. It is observed that adding 30% Rap to the asphalt mixture will decrease the rut depth by (60%) at (60ºC)

References

1. Copeland A 2011 Reclaimed asphalt pavement in asphalt mixtures: State of the practice. United States. Federal Highway Administration. Office of ResearchÂ .
2. Croteau J M 2005 Performance and cost benefits of asphalt pavement recycling. In: Semi-Annual meeting: Asphalt Recycling and Reclaiming Association (ARRA).
3. T. F. Fwa, S. A. Tan, and L. Y. Zhu, "Rutting prediction of asphalt pavement layer using C-φ model," J. Transp. Eng., vol. 130, no. 5, pp. 675–683, 2004.
4. E. Coleri, J. T. Harvey, K. Yang, and J. M. Boone, "Investigation of asphalt concrete rutting mechanisms by Xray computed tomography imaging and micromechanical finite element modeling," Materials and Structures, vol. 46, no. 6, pp. 1027–1043, 2013.
5. Z. Z. Li, S. F. Chen, W. D. Liao, and H. X. Chen, "Evaluation of anti-cracking performance of modified HMA in stress absorbing layers under low temperature," China Journal of Highway and Transport, vol. 25, no. 4, pp. 29–35, 2012, in C.hinese.
6. Abdel-Motaleb M. Flexible pavement components for optimum performance in rutting and fatigue. Zagazig Univ J 2009
7. Carroll, R. G. Jr., J. C. Wall, and R. Hass. Granular Base Reinforcement of Flexible Pavements Using Geogrids. In Geosynthetics 987: Conference Proceedings, New Orleans, February 24–25,1987, pp. 4657.
8. Qasim, H. A. 2016. "Experimental Evaluation for Local Reclaimed Asphalt Pavement", MSc Thesis, the Highway and Transportation Engineering Department, College of Engineering, Al-Mustansiriayah University.
9. ASTM-D5. 2018. "Standard Test Method for Penetration of Bituminous Materials." Annual Book of Standards American Society for Testing and Materials 04.03.
10. ASTM-D4402. 2018. "Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer." Annual Book of Standards American Society for Testing and materials 04.03.
11. ASTM-D36. 2018. "Standard Test Method for Softening Point of Bitumen (Ring- and-Ball Apparatus)." Annual Book of Standards American Society for Testing and Materials 04.04.
12. ASTM, D70. 2003."Standard Test Method for Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method). " Annual Book of ASTM Standards 4.
13. ASTM- D2172. 2012. "Standard Test Methods for Quantitative Extraction of Bitumen Form Bituminous Paving Mixtures", Annual Book of Standards American Society for Testing and Materials, 4(3), USA.
14. BS EN 12697 - 22, 2003. (n.d.). 12697-22.(2003). "Bituminous Mixtures– Tests Method for Hot Mix Asphalt." Part 22: Wheel Tracking Test.
15. BS EN 12697 - 33, 2003. (2003). 12697-33 2003. "Bituminous mixtures-Test Methods for Hot Mix Asphalt, Part 33: Specimen Prepared by Roller Compactor. London UK: British Standards Institution.