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LABORATORY RUTTING PERFORMANCE OF POLYMER MODIFIED ASPHALT MIX

SURIANI BINTI HASSIN

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Master of Engineering (Civil-Transportation and Highway)

Faculty of Civil Engineering
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I declare that this thesis entitled "*Laboratory Rutting Performance of Polymer Modified Asphalt Mix*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Specially to my beloved Dad and Mom,

My beloved siblings

To my Supervisor

My friends

-Thank You-

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Suriani Hassin
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ABSTRACT

Polymer Modified Asphalt (PMA) is an option to enhance the performance of bituminous pavement layers. PMA offers many benefits to the pavement such as improved resistance to rutting, fatigue cracking, binder hardening and improve adhesion of binder to aggregate. Methods of compaction influenced the pavement and gave different impacts on the PMA mixtures properties. The objective of the study was to evaluate the rutting performance of PMA mixture compacted using Marshall and Gyratory compactors. Two mixtures of PMA were prepared which were PMA 10 and PMA14. After the samples were compacted using Marshall and Gyratory compactors, the samples were then tested for Stability and Flow to obtain OBC and others properties of the samples. Resilient Modulus (M_r) was also obtained for the verification samples using Indirect Tensile Strength Test and rutting performance for the mixes are determined using Wheel Track Test. All of the tests on these mixtures were conducted and evaluated in the Highway and Transportation laboratory UTM. The results shows Gyratory compaction method suggests that lower OBC could be obtained as compared to Marshall Compaction and Gyratory compaction method improved the resistance to rutting. The difference in aggregate gradation of the mixes affects the Optimum Bitumen Content when compacted using both methods.

ABSTRAK

Polimer Terubahsuai Asfalt (PMA) adalah satu pilihan terbaik bagi meningkatkan prestasi lapisan turapan bitumen. PMA menawarkan banyak manfaat kepada turapan jalan seperti rintangan yang lebih baik terhadap aluran, retak lesu, pengikat yang baik antara batu dan bitumen serta meningkatkan pengikat agregat. Kaedah pemadatan mempengaruhi turapan jalan dan member impak yang berbeza pada sifat-sifat campuran PMA. Tujuan kajian ini adalah untuk menilai prestasi aluran campuran PMA menggunakan OBC yang diperolehi daripada dua kaedah pemadatan iaitu Marshall dan Gyratory. Dua campuran PMA telah disediakan bagi menjalankan kajian ini iaitu PMA 10 dan PMA 14. Selepas sampel dipadatkan dengan menggunakan pemadat Marshall dan Gyratory, sampel kemudiannya diuji untuk ujian Kestabilan dan Aliran bagi mendapatkan OBC dan lain-lain sifat sampel. Ujian Daya Tahan Modulus (M_r) juga diperolehi untuk sampel pengesahan menggunakan Ujian Kekuatan Tegangan dan prestasi aluran bagi campuran ditentukan menggunakan Ujian Jejak Roda. Kesemua ujian ke atas campuran ini telah dijalankan dan dinilai di Makmal Pengangkutan & Jalanraya UTM. Keputusan dalam kajian ini menunjukkan bahawa kaedah pemadatan Gyratory dapat memperbaiki rintangan aluran jalan dan perbezaan dalam pengredan agregat menjejaskan Kandungan Bitumen Optimum apabila dipadatkan menggunakan kedua-dua kaedah pemadatan. Sebagai kesimpulan, kaedah pemadatan Gyratory menunjukkan bahawa OBC yang lebih rendah boleh diperolehi berbanding kaedah pemadatan Marshall dan ia mempengaruhi prestasi aluran campuran PMA.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
PMA10	-	Polymer Modified Asphaltic Concrete Wearing With 10 mm Nominal Maximum Aggregate Size
PMA14	-	Polymer Modified Asphaltic Concrete Wearing With 14 mm Nominal Maximum Aggregate Size
ASTM	-	American Society for Testing and Materials
HMA	-	Hot Mix Asphalt
JKR	-	Jabatan Kerja Raya
MS	-	Malaysian Standard
TMD	-	Theoretical Maximum Density
VTM	-	Void Ratio in Mix
VFB	-	Void Filled Bitumen
TSR	-	Tensile Strength Ratio
OBC	-	Optimum Bitumen Content
g	-	gram
mm	-	milimere
Mpa	-	Megapascal
N	-	Newton
ºC	-	degree celcius
%	-	percent

LIST OF APPENDIX

CHAPTER I

INTRODUCTION

1.1 Background

The development of a country is closely linked with the efficiency of the transportation system, particularly in the road network. Today, our government is very committed to improve the performance of the road network as it serves as the basic accommodation to the people and also as a major catalyst in stimulating the economic growth. Generally, the quality of highway road with toll access is better than the federal road in Malaysia, thus, under RMK-10, the government under Ministry of Public Work agreed to use new modification on the pavement to replace the conventional pavement in construction of new federal road especially in term of longer life expectancy, lower life cycle cost and accommodate higher axle loads.

The launching of Polymer Modified Asphalt (PMA) for the road maintenance in Malaysia by the Ministry of Work, Y.B Dato' Shaziman Bin Abu Mansor as reported in The Star newspaper on 21st June 2010 at Bentong, Pahang has lead to several studies on the effectiveness of PMA on several targeted road in Temerloh-Mentakab, Karak-Bukit Tinggi and federal road in Kuantan. The studies conducted show favourable results of the uses of PMA as it extent lifespan of the road as compared to the conventional asphalt pavement.

PMA is produced by a mixture of natural or synthetic polymer with conventional bitumen. This mixture has a high resistance to rutting and cracks and it increase the pavement life compared to conventional methods. The effectiveness of PMA also proven through research conducted in Kelantan, as it well known that this state always exposed to the flood phenomenon. The results from this studies shown that the uses of PMA can reduce the formation of potholes in the road surface and reduce damages due the flood.

Therefore, according to the positive results and the effectiveness of Polymer Modified Asphalt, the Ministry of Work has planned 5% of new road pavements and maintenance will use PMA. Although the initial cost of PMA will be higher than the conventional asphalt, PMA will be able to reduce the cost at least 20% in long term, (The Star, June 2010).

1.2 Problem Statement

Even though all the road networks in Malaysia are designed with a lifespan of 10 years, the damages on the pavements still occurs earlier than expected. Among the major factors contributing to this damage is the increasing number of vehicles and traffic axles load significantly. In addition, the weather phenomena in Malaysia such as heavy rainfall also contributed to the damages of the road pavement. As a result, various forms of damages such as rutting, potholes, cracking, raveling, and shoving occur.

The increased traffic densities, increased loads, increased axle pressures, shortage of good quality aggregates, and the effects of high and low ambient temperatures contributes to the pavement distress. The uses of PMA prevent rutting from taking place. YB Dato’ Shaziman, The Star, June 2010 on his speech said that

the PMA may also improve the aging characteristics of a binder so that the deleterious impact of oxidative aging is delayed, leading to a more durable and stable pavement. Better adhesion helps to minimize drain down at the time of construction and also helps to reduce the tendency of the pavement to ravel once it has aged.

However, compaction of PMA plays a major role in the performance of these pavements. The properties of the mixture such as density and air voids are highly dependent on the method of compaction. Compaction Methods such as Marshall and Gyratory will influence the Optimum Bitumen Content (OBC). These properties in turn affect pavement performance indicators, such as resistance to rutting. Therefore next to mix design, degree of compaction must be considered the main quality parameters of a laid asphalt mixture. A well designed and well produced mixture performs better, has better durability, and has better mechanical properties when it is well compacted, (Naeem Aziz Memon, 2006).

1.3 Aim and Objectives of Study

The aim of this research is to evaluate the rutting performance on Polymer Modified Asphalt (PMA) using Optimum Bitumen Content (OBC) obtained from Gyratory and Marshall Compactors.

The objectives of this study are:

a) To compare PMA mixtures properties by using two method of compaction, using Marshall and Gyratory Compactor methods.
b) To determine the rutting performance of PMA10 and PMA 14 using OBC obtained in both compaction methods.

1.4 Scope of the Study

The scope of study focused on the rutting performance of Polymer Modified Asphaltic (PMA) which is PMA 10 and PMA 14. The bitumen used was Performance Grade PG-76. The mixed were compacted using Marshall and Gyratory Compactors. The Optimum Bitumen Contents (OBC) obtained from both compactions was used to determine the rutting performance in PMA 10 and PMA 14 samples. The specification was referred based on JKR/SPJ/2008-S4. The aggregates were obtained from MRP Quarry located at Ulu Choh, Pulai and bitumen PG-76 was obtained from Highway and Transportation Laboratory. All laboratory works were performed at Highway and Transportation Laboratory in University Teknologi Malaysia.

1.5 Significant of Study

In this study, it is expected that the properties of the PMA 10 and PMA 14 will be significantly different according to the method of laboratory compaction which are Marshall and Gyratory. The gyratory compaction method versus Marshall will give more consistent results while the particle orientation closer to field not like Marshall which sometimes breaks it and this method can use larger aggregate. Besides that, OBC obtained from both compaction methods were used to determine rutting performance and it is expected that OBC obtained from Gyratory lower than Marshall Compaction and therefore it improve the resistance to rutting. In my opinion, the differences in aggregate gradation of the mixed affect the OBC when compacted using both methods.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As Malaysia's roads become more congested, the Works Ministry has the daunting task of ensuring they are constantly in good condition and safe for motorists. With the convenience of road development comes issues that cause specific inconvenience to the people, namely poor road condition during rainy seasons, traffic congestion and road accidents. Generally, there is insufficient funding to ensure roads are in excellent condition. Hence, many road agencies address the poor road condition by immediately patching up the potholes with bitumen cold mix as a temporary fix since hot mix is generally unavailable during the rainy season. Overlay will generally be carried out after the rainy season is over. However, when the affected pavement covers a large area, this patch-up may not be suitable. A better alternative will be to use a more durable mix at the project implementation stage, whereby the costlier material may not only provide a durable mix but also lower life cycle cost. The Public Works Department, under the Works Ministry is identifying durable material to be incorporated in the mix that will enhance its properties. Initial studies have shown that Polymer Modified Asphalt can be used to replace the 60-70 penetration grade bitumen in the mix. The