THE INFLUENCE OF WASTE MOTOR ENGINE OIL IN WARM MIX ASPHALT

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This thesis is dedicated to my parents for their love and support throughout my life.

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ABSTRAK

Terdapat banyak kajian yang telah dilakukan untuk menentukan bahan buangan yang sesuai untuk digunakan untuk meningkatkan ketahanan terhadap retakan keletihan akibat pengerasan pengikat dan memperbaiki perekat pengikat kepada agregat. Dalam kajian ini, prestasi sisa minyak enjin motor digunakan sebagai pegubah bitumen dalam turapan konkrit asfalt telah diselidik. Kajian ini memberi tumpuan kepada penambahan sisa minyak enjin motor pada peratusan yang berlainan, iaitu 0%, 3%, 4% dan 5% oleh berat bitumen. Tujuan kajian ini adalah untuk mengkaji kesan sisa minyak enjin motor terhadap sifat kejuruteraan terhadap AC14. Sisa minyak enjin motor telah diadun bersama-sama dengan bitumen menggunakan pengadun ricih yang tinggi pada kelajuan 1000rpm selama 1 jam pada suhu 140˚C sebelum digunakan untuk ujian prestasi. Prestasi sampel telah dinilai melalui ujian Kestabilan Marshall, Modulus Kebingkasan dan Rayapan Dinamik.

ABSTRACT

There are many studies have been done to determine the suitable waste materials that can be used in order to improve resistance to rutting and fatigue cracking due to binder hardening and improve adhesion of binder to aggregate. In this study, the performance of Waste Motor Engine Oil (WMEO) as bitumen modifier in asphalt concrete pavement was investigated. This study focuses on the addition of WMEO at different percentages, namely, 0%, 3%, 4% and 5% by the weight of bitumen. The aim of this study is to investigate the effect of WMEO on engineering properties of Asphaltic Concrete 14. The WMEO was blended together with bitumen using a high shear mixer at a constant speed of 1000rpm for 1 hour at 140˚C before being used for performance tests. The performance of the samples was evaluated through Marshall Stability, Resilient Modulus and Dynamic Creep test.

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LIST OF ABBREVIATIONS

HMA	Hot Mix Asphalt
WMA	Warm Mix Asphalt
BRHA	Black Rice Husk Ash
WEO	Waste Engine Oil
WMEO	Waste Motor Engine Oil
JKR	Jabatan Kerja Raya
ASTM	American Society for Testing and Materials
BS	British Standard
VFB	Voids in Aggregate Filled with Bitumen
VTM	Voids in Total Mix
VMA	Voids in Mineral Aggregate
AC14	Asphaltic Concrete 14
UTM	Universal Testing Machine
ITS	Indirect Tensile Strength

CHAPTER 1

INTRODUCTION

1.1 Introduction

Currently, majority of the Malaysian roads are paved with Hot Mix Asphalt (HMA) or asphaltic concrete as its surface layer due to more superior material provided besides suitable for higher traffic volume design. HMA is a combination of approximately 95% of aggregates, which is a mix of crushed stone, gravel and sand while the other 5% is bitumen. These ingredients are mixed at high temperatures, approximately 150-180˚C. The main concern with the production of HMA is, it requires a large amount of energy as well as releases a massive amount of emissions into the environment due to the higher production and compaction temperature of the asphalt mix (Singh & Gupta, 2016). Therefore, the road construction energy is looking for an alternate technology that able to reduce the amount of energy required to produce the HMA. Warm Mix Asphalt (WMA) is one of the rising technologies that are more environmentally friendly compared to HMA.

WMA is a technology that was introduced with aims to reduce the mixing and production temperature from 150-180˚C for HMA to 100-140˚C, reduce emissions at asphalt plant, low fuel usage during aggregate heating process, minimize the polluting emissions, longer hauling distances, less bitumen aging during construction which helps to extend the life of the road and earlier opening to traffic. The implementation of WMA technology has been established among local authorities, pavement industries and researchers all over the world due to several advantages as compared to HMA in several aspects. In the aspect of environmental, asphalt mixing contributes one of the most energy-intensive processes as compared to other industrial activities such as electricity, fossil fuels, mining, chemical industry and others. The temperature as low as 10-40˚C will be produced during the process of WMA which is lower than HMA production

temperature while effectively minimize the production of fumes like carbon dioxide, nitrogen oxide and sulphur dioxide hence reducing exposure to the paving workers, contractors, and local authorities besides public (Abdullah et al., 2015). In the aspect of economical, the reduction of fuel usage will depend on the amount of temperature. The energy consumption of WMA is said to be around 60 to 80% of the HMA energy consumption. In terms of construction benefits, the reduction of temperature difference leads to the reduction of road construction and opening time and as well as makes certain road construction in a pleasant situation.

There is a growing awareness to reuse waste materials also to minimize the consumption of bitumen, one of the most valuable materials used in pavements. The incorporation of waste motor engine oil in asphalt mixtures is crucial in order to reduce the use of bitumen directly obtained from oil sources. This is vital for the sustainability of road paving construction development (Fernandes,2017). Waste motor engine oil is typically petroleum and consists of nondegradable components that are hard to be decomposed. The waste motor engine oil is also contaminated by impurities during physical and/or chemical processes. Therefore, the oil is no longer suitable to be used for its original purpose. During the engine operation, heavy metals like lead, calcium, zinc, and magnesium gradually accumulate in the motor engine oil (DeDene, 2011). These metals will cause damage to the environment if improperly disposed of such as water and soil pollution.

1.2 Problem Statement

According to Samsuddin & Masirin (2016), road infrastructure can be defined as the fundamental facilities, services, and installation that are needed for the functioning of transport highway, roads, and streets. Road infrastructure plays a significant role as the main element in the road transport system in a developing country like as in Malaysia since it is the key mode of national transportation. However, as a rapid increase in public road construction in Malaysia, many roads reach the end of their service life earlier than their design life (Shehu et al., 2014). A few factors that cause a decrease in the performance of road structure are an increase in traffic volume, improper road surface drainage, improper design, and poor maintenance. Cracks are the most common pavement distresses that usually occur in pavement structures (Bughrara, 2008).

As the economic growth rapidly, also due to modernization, there are many vehicles used all over the world including Malaysia as one of the developing countries. The motorcars need to be serviced after a specific time or mileage usage to ensure good performance and conditions. Changing engine oil is one of the most compulsory changing during services. Waste motor engine oil can lead to water and soil pollution due to improper disposal. The consequence can be seen from the eutrophication process. In this process, a thin layer of oil appears on the surface of a river or a lake, which can prevent the sunlight, block photosynthesis as well as disturb the aquatic life from receiving oxygen supply (Kamaruddin, 2014).

Nowadays, there is a growing awareness of global warming. One of them is the greenhouse effect, which can be described as a condition where the short wavelengths of visible light of the sun passing through a transparent medium which is then converted to heat after being absorbed. When using HMA technology, the construction of asphalt pavement emits greenhouse gases as well as other hazardous gases that cause critical air pollution due to massive amounts of energy consumption. Therefore, the use of WMA should be implemented since it has a high potential in energy efficiency and emission reduction because of lower mixing and production temperature compared with HMA (Wu & Qian, 2014). According to Quintana et al. (2015), WMA mixtures not only release lesser polluting emissions during their manufacturing and construction process, but also the energy savings are approximately 30%.

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