Faculty of Engineering

THE EVALUATION OF MARSHALL PROPERTIES OF OIL PALM FLY ASH (OPFASH) AS A FILLER MATERIAL IN ACW 20 HOT MIX ASPHALT (HMA)

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“*Dedicated to my beloved ones….*’’

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ABSTRACT

Increasing number of traffic loads at present and future is a main issue in highway construction. Factors such as durability, strength and economic need to be consider into account in design and construction of road pavement. Many researches have been conducted to explore material which can produce good properties for asphalt pavement. This study was conducted to evaluate the suitability of OPFASH as replacing material for alternatives filler with normal ACW 20. The asphalt cement use varies from 4.5% to 6.5% and having penetration grades of 80/100. Marshall Test was done to evaluate this study and compare the physical properties of OPFASH Hot Mix Asphalt and normal Hot Mix Asphalt. The ACW 20 for the normal mix aggregate and OPFASH does not satisfied JKR requirement for void in total mix mean. The optimum binder content for the normal mix asphalt was 4.83% and 5.13% for the OPFASH mix.

ABSTRAK

Pertambahan beban lalulintas pada masa kini dan masa hadapan merupakan salah satu isu utama dalam pembinaan jalanraya. Faktor-faktor seperti ketahanlasakan, kekuatan dan ekonomi perlu dipertimbangkan dalam merekabentuk dan pembinaan jalan raya yang memainkan peranannya sebagai salah satu media perhubungan yang terpenting. Banyak kajian telah dijalankan untuk mencari bahan baru atau bahan ganti untuk menghasilkan ciri-ciri yang baik bagi turapan berbitumen. Kajian ini dijalankan bagi mengkaji kesan terhadap ciri-ciri Marshall dan kesesuaian penggunaan bahan OPFASH sebagai bahan penganti dalam campuran panas asfal ACW 20. Kandungan asfal berbeza dari 4.5% ke 6.5% dengan gred penembusan 80/100. Keputusan kajian menunjukan campuran menggunakan agregat biasa mempunyi ketumpatan yang lebih besar tetapi campuran menggunakan OPFASH akan mempunyai kestabilan yang lebih tinggi ACW20 campuran agregat biasa dan OPFASH gagal menepati piawaian JKR lompang dalam campuran (VTM. Kandungan asfal optimum untuk campuran biasa adalah 4.83% manakala 5.13% untuk campuran OPFASH.

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HMA	Hot Mix Asphalt
VMA	Voids in Mineral Aggregates
VTM	Voids in Total Mix
VFA	Voids Filled with Asphalt Cement
ASTM	The American Society for Testing and Materials
OAC	Optimum Asphalt Content
OPFASH	Oil Palm Fly Ash
SSD	Saturated Surface Dry
JKR	Jabatan Kerja Raya
UNIMAS	Universiti Malaysia Sarawak

LIST OF SYMBOLS

%	Percentage
ºC	Degree Celsius
µ	Micro
mm	Millimeter
m	Meter
VB	Volume of constituent binder
M	Mass of specimen
V	Bulk volume of specimen
MBA, VBA	Mass and Volume of absorbed binder
MB	Mass of constituent binder
VB	Volume of constituent binder
VMM	Volume of void-less mix
VA	Volume of air between coated aggregate particles in the mix
MG	Mass of aggregate
VG	Bulk volume of aggregate
VGE	Effective volume of aggregate
Wa	\Weight of specimen in air (kg)
Ww	Weight of specimen in water (kg)
ρw	Density of water (= 1000 kg/m3)
Wpa	Weight of specimen and paraffin wax coating in air (kg)
Wpw	Weight of specimen and paraffin wax coating in water (kg)

Gp	Relative density of paraffin wax
PAG	Binder absorption, % of mass of aggregate
PB	Binder content, % of total mass of specimen
ρB	Density of binder
ρG	Bulk density of aggregate
m3	Meter cubic
mm	Mili Meter
kN	Kilo Newton
kg	Kilogram
g	Gram

CHAPTER 1

INTRODUCTION

1.1 General

Road as one of land transportation infrastructure is very important in supporting the economic for both regional and national development. The quality of material for road construction will also influence the road performance. During 1900's, the bituminous paving technique was first used on rural roads and so as to handle rapid removal of fine particles in the form of dust which was caused due to rapid growth of automobile [Roberts et al. 2002**].** Construction of highway involves huge outlay of investment. A precise engineering may save considerable investment as well a reliable performance of the in-service highway can be achieved. Two things are of major considerations in this regard are the pavement design and the mix design (Das, 1998).

Nowadays, better techniques and methods have been developed and implemented for improving roadway lifetime. Mix design is one of the factors that play a strong role in roadway performance and life. A good mix design is expected to result in a mix which is adequately:-

i. Strong
ii. Durable
iii. Resistive to fatigue and permanent deformation
iv. Environment friendly
v. Economical

Asphalt mix design is a method of designing pavement structure. The process of designing including selecting appropriate graded aggregate materials and optimum bitumen content, so that the most suitable combination of composition and properties will give required strength or stability to withstand repeated load applications and get the most economic of pavement structure. For asphalt mix design, there are two mix design methods which are Hveem Mix Design Method and Marshall Mix Design Method. [Sandah, 2008]

Marshall Method was the commonly used in the Malaysia road construction which is easy to conduct and simpler. The Marshall Mix Design Method was originally developed to address specific mix design issues confronting the USCOE during World War II. Therefore, it was developed to be simple, light, quick, and reasonably accurate for the wheel loading of the time. Since then it has been

modified and supplemented to address new concerns but the basic testing apparatus and selection criteria remain the same.

1.2 Statement of Problem

Nowadays, the road pavement or asphalt surface is exposed to higher loading because of the increasing numbers of the transportation or vehicles on road. When this road pavement is subjected to primarily repeat loading over a period of time, it can caused to permanent deformation or rutting, fatigue, cracking and skidding problems. Thus, the road pavement has a low durability and less workability. All of these problems regarding to road pavement can leads to any unfortunately incident such as accident.

For these several decades, lots of testing and researches had been done to find the most suitable alternatives materials to improvise the road pavement. One of the common alternatives ways taken in concern is by manipulating filler material in the asphalt mix design. It is believe that modification of asphalt mix design materials used may improve the rheological behavior of the mixes which provide the better service life of the road pavement and strengthen the mix.

Traditionally aggregates, sand, bitumen or asphalt, and Portland cement are used in road construction. The demand of these materials for construction purpose is increased rapidly but naturally material become shortage in nature. The economic factors relating to the materials used in construction mainly derive from the costs of extracting the material, processing and hauling it to the site.

Besides that, the environmental disturbance is made up of factors such as disturbance to the landscape leading to possible dereliction and the depletion of natural resources. Disposal issue of the waste products is a challenge today. Some of the materials are not biodegrade and often lead to waste disposal crisis and environmental pollution (Chua, 2008).

For other alternative, industrial waste such as fly ash, blast furnace slag, colliery spoil, marble dust, waste tyres are used in the road construction. For instant, Malaysia is one of the largest countries that produced oil palm to other countries all around the globe. This oil palm has caused an excessive waste from its production in the factory and leads to disposal problem. Perhaps this oil palm waste can be used as alternative filler in asphalt mix design.

By burning the waste of oil palm, it can produced oil palm fly ash or known as OPFASH. Recently, OPFASH is found to be useful and economical alternative filler replacing cement in concrete mix. However, the workability and capability of using

OPFASH is remaining unknown. It is hope that the used of OPFASH will decrease the cost of construction and increase the quality of asphalt mixtures.

1.3 Aim and Objective

There were 3 objectives in this study that need to be achieved:

i. Determine the Marshall properties of hot mix asphalt ACW 20 by using Oil Palm Fly Ash (OPFASH) as a replacing material for alternatives filler with normal ACW 20.

ii. Evaluate the Oil Palm Fly Ash (OPFASH) suitability as filler in Hot Mix Asphalt.

iii. Compare the optimum binder content for both normal ACW 20 and Oil Palm Fly Ash (OPFASH) ACW 20.

1.4 Scope of Study

In order to investigate the effects of OPFASH on Hot Mix Asphalt (HMA) properties, the scope of the study was included preparation of ACW 20 Marshall samples with bitumen content without additive were 4.5%, 5.0%, 5.5%, 6.0% and 6.5% as control samples. The Marshall Test was conducted to determine optimum bitumen content and Marshall Properties. This research will be carrying out according to the Marshall Mix Design and Marshall Stability and Flows test.

Total number of 15 samples of normal ACW 20 (control sample) and 15 samples of OPFASH (modified sample) as the replacing material are prepared and tested referring to the AASHTO manual. The result on the density, stability, flow, voids in total mix, voids filled bitumen and stiffness from the modified sample and control sample were compared and analyze according to specification stated in JKR/SPJ/1988. All the sample preparation and testing was conducted at Civil Engineering Laboratory (Concrete Laboratory and Highway & Transportation Laboratory), Universiti Malaysia Sarawak.