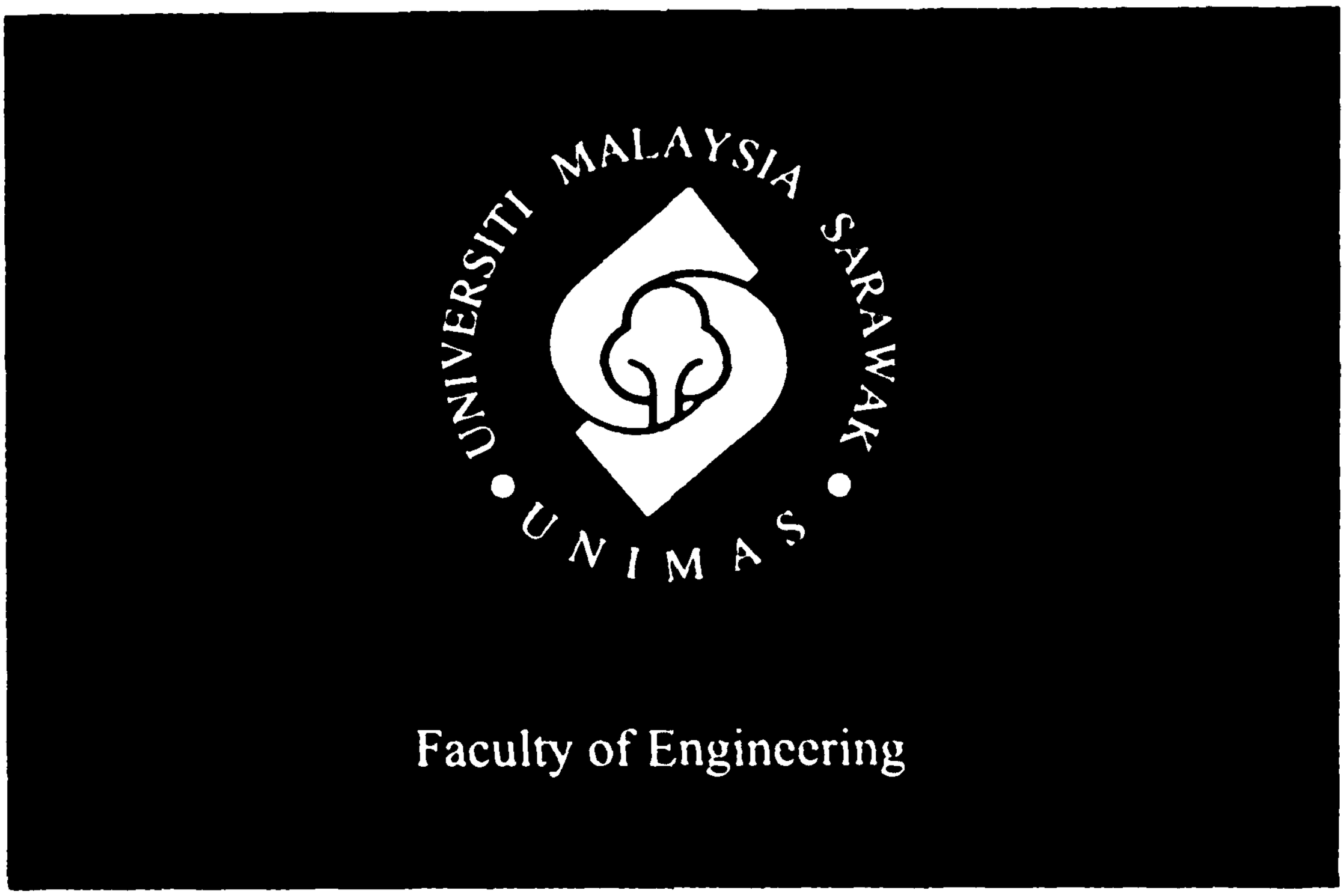

"EVALUATION OF MARSHALL PROPERTIES OF ACW 14 USING RIVER SAND AND CARBIDE LIME AS FILLER SUBJECTED TO 75 NUMBERS OF COMPACTION"

Fiza Firdauz Bin Abdul Rahim (15704)

Bachelor of Engineering with Honours
(Civil Engineering)
2009

Dedicated to my beloved family, friends and everyone

Thanks for everything

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude to Allah S.W.T. for His Blessing for giving me the precious effort to complete this study successfully.

My special and sincere appreciation dedicated to my Supervisor, Mr. Larry Silas Tirau, for his valuable knowledge, guidance and enthusiastic support in my study. Without his help and patient, I would not be able to finish this study. His contribution is the most valuable asset in this study.

Next, I would like to extend my special gratitude and appreciation to the UNIMAS for providing the equipments and also to the laboratory technician, Mr. Saiful of Highway laboratory and Mr. Adha of concrete laboratory, UNIMAS, for their useful guidance, opinion and technical advice throughout the study.

A special thanks to Mr. Tan of Global Upline Sdn. Bhd. and not forgotten Mr. Chan and Mr. Romeo of PPES for giving me the information and the necessary material for me to conduct my study. Without them, it would be a gold digging in searching for the material I need.

This dissertation is dedicated to my beloved parents and my sister. Their unwitting commitment of patient and understanding is greatly appreciated.

Finally, thanks to all my lecturers, colleagues especially to Reagan Entigu, Mohd Azlan Shah and Muhammad Wazizi Hamzar who had in their spare time help me doing the laboratory work. My sincere thanks also goes to everyone who involved either directly or indirectly in preparing this report for their diligent help and respective jobs.

ABSTRAK

Konkrit asfalt campuran panas (HMA) adalah campuran yang selalu digunakan dalam pembinaan lapisan jalan. Perkara yang menjadi tumpuan adalah untuk menjadikan sesuatu campuran itu mempunyai ketegasan dan kealiran yang tinggi untuk mengelakkan kerosakan jalan raya. Kebanyakan campuran panas asfalt menggunakan debu simen dan debu kuari sebagai bahan dalam campuran. Objektif kajian ini adalah untuk menilai parameter ujian Marshall untuk dua jenis sampel yang menggunakan "carbide lime" dan pasir sungai telah digunakan dan dicampurkan dalam campuran asphalt haus AC'W 14. Sampel untuk aggregate dipilih dengan teliti untuk mengelakkan batu yang panjang dan batu yang nipis. Kedua-dua campuran disediakan dengan 100% kehendak nilai bagi material pengisi bagi memahami keseinambungan menambah "carbide lime" dalam campuran panas asphalt. Kajian ini adalah berdasarkan lompang dalam campuran (VTM), lompang dalam aggregate mineral (VMA) dan lompang dipenuhi bitumen (VFB). Parameter ini adalah perlu bagi mencari nilai optimum kandungan bitumen dalam campuran. Daripada data yang telah dianalisa, didapati bahawa kebanyakan campuran menunjukkan peningkatan dari nilai tegasan dan kealiran. Walaupun keperluan JKR untuk lompang dalam campuran (VTM) dan lompang dipenuhi bitumen (VFB) dan juga sesetengah keperluan yang tidak dipenuhi, boleh disimpulkan bahawa campuran yang menggunakan gentian pengisi "carbide lime" amat berguna dan kajian makmal seterusnya untuk mencari parameter data yang memenuhi keperluan JKR boleh diteruskan pada masa hadapan.

ABSTRACT

Hot mix asphalt (HMA) mixture is widely used in road paving. The concern of having a mixture that has a high stability and flow ability is necessary to avoid premature deterioration and defects. Most HMA used a mixture of Ordinary Portland Cement (OPC) and quarry dust as filler material. The objective of this study is to evaluate the Marshall Mix properties for both types of mixes using river sand and carbide lime as filler material in ACW 14 mix. Samples were prepared carefully to avoid elongated and flaky aggregates. Both the mixture are prepared 100% of each required percentage of filler to understand the significant of adding carbide lime in HMA mix. The study will be based on the voids in total mix (VTM), voids in mineral aggregates (VMA) and voids filled with bitumen (VFB). These properties of asphalt mix are necessary to determine the optimum binder content of asphalt. From the data that had been analyze, it is found that most of the asphalt mix shows a significance increase in stability and flow ability. Though the JKR requirements of voids in total mix (VTM), voids filled with bitumen (VFB) and some of the requirement were not met, it could be concluded that the mix replaced by carbide lime is useful and further laboratory work to find the necessary envelope that meets the JKR requirement could be assessed in future.

TABLE OF CONTENTS

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: METHODOLOGY

CHAPTER 4: DATA ANALYSIS AND DISCUSSION

CHAPTER 5: CONCLUSION AND RECOMMENDATION

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

LIST OF SYMBOLS AND ABREVIATION

HMA	Hot mix asphalt
ACW	Asphalt concrete wearing course
ACW $14_{river\ sand}$	ACW 14 using river sand filler
ACW $14_{carbilde\ lime}$	ACW 14 using carbide lime filler
FAA	Federal Aviation Association
μ	Micro
°C	Degree Celsius
$^{o}/_{o}$	Percent
g	Gram
mm	Millimeter
N	Newton
c.c	cubic centimeter
S.G.	Specific gravity
P_b	Percentage of asphalt concrete by total weight of mixture

LIST OF APPENDIX

CHAPTER 1

Introduction

1.0 Background

In recent years, the government of Malaysia has come into interest in finding new alternative of constructing pavement, doing research and development for roads, bridges and highways and the usage of new pavement and surfacing pavement. The work aspect of construction of road is still in accordance to the Arahan Teknik Jalan by Jabatan Kerja Raya Malaysia (JKR) and the Standard Specification for Road Works by JKR Malaysia. The Arahan Teknik Jalan adopts American Association of State Highway and Transport Official (AASHTO) to specify their standards according to the availability of material and unbound condition that faced during construction of pavement.

Besides that, with respect to Ministry of Transportation, MOT, road construction and overlaying of asphalt according to design and standards had taken into great consideration for designing of asphalt pavement. Revise version of standards from JKR has means to use these concepts to determine the pavement design and its overlay according to traffic condition and ESALs loadings. In the JKR

20601/LK/0156/KP/05 is shown that different gradation of asphaltic concrete was used for different type of roads requirement and categories.

As one of the basic requirements of a pavement design is to withstand the intense loading from traffic. The thickness of the pavement must be sufficient to deal with the stresses at the surface without causing distress to the foundations, the overlaying layers or the sub-grade. It is important that the foundation level meets the requirement and the design of the foundation should meet the serviceability requirement. The design of each pavement should be done by identifying the type of roadway, traffic volumes, weather conditions and the intended use of pavement.

For roads and highway design, criteria basis for mix designs are evaluated base on the ESAL's loadings and other factors such as the mix materials, the desired surface texture and environmental condition. The mix materials should be considerable economical in design and available to avoid unwanted delay to projects. Soil consideration of the site should be taken into account where the type of soil and its classification should be carefully analyzed. A careful analysis of the soil condition will provide information for engineers to come up with suitable solution to overcome problems of the soil condition.

Asphalt concrete has evolved with wide range of new asphalt pavement for wearing coarse such as Stone Mastic Asphalt (SMA), usage of Porous Asphalt and wearing course using Polymer Modified Asphalt. The newest method in designing HMA mix is called Superior Performing Asphalt Pavement which is known as Superpave. Most asphalt is categorized as hot mix asphalt (HMA) as the name

suggested, is any asphalt mixture that is mixed while hot. The mixture of binder and aggregates are heated to get fluidity to coat and to dry the aggregate respectively.

Asphalt pavement especially hot mix asphalt had become a synonym in paving structure. The asphaltic concrete is considered a reliable and cost effective product to be used as pavement especially in road construction rather than of rigid pavement. These asphaltic concrete were choose base on its criteria and the optimum binder content were the key point of designing a mix with high stability and flow. This is achieved by Marshall Test.

There are different types of mix design in asphaltic concrete as an example, in United States of America, each states of the country have their own specification for road work and design specification for flexible pavement design. Each state proposed their own HMA design to acquire and significantly counter the problems occurring on their pavement. Some of the states considered lime filler or any usage of limestone in their mix as an essential in HMA mix.

In Malaysia, the design of asphalt mix is based on JKR standards. These standards were set as a guide for road builders in constructing their road. The optimum binder content achieved by doing Marshall Test is used in determining hot mix asphalts that have high stability and flow.

1.1 Problem Statement

Asphalt concrete has become known to deteriorate with time and climate condition. It is a major and solid problem towards achieving a better performance asphalt pavement. Research on several methods of designing through gradation of aggregates and material in achieving a better pavement is done constantly to overcome the problems. Therefore, the needs to understand and relating the properties of different mix is essential to find the stability of a HMA.

1.2 Aim

The aim of this study is to find the volumetric properties of two difference mix that uses ACW 14 aggregate mix and filler material as of sand and carbide lime. It is to differentiate the stability and flow of both types of mixes.

1.3 Objectives

The objective of this study is to evaluate the Marshall properties of hot mix asphalt by using Marshall Method Mix Design of ACW 14 which subjected to carbide lime and river sand as filler material. The mix that is prepared will be of river sand as control sample and carbide lime as replacement filler for river sand. The samples are subjected to 75 compaction blow which in accordance to JKR

specification. It is to understand the significant usage of carbide lime as filler material and to determine the Marshall Stability and flow for both types of mixes.

1.4 Scope of study

In this study, the material that is used for HMA is of nominal maximum size of aggregates of 14 mm (ACW 14). The mixture of HMA is prepared in accordance to the specification by JKR standards. The mixture of hot mix asphalt is ACW 14 and shall be made of two different types of filler material which are of river sand and carbide lime.

CHAPTER 2

Literature Review

2.0 Introduction

Hot mix asphalt (HMA) has been used widely and constitutes more than 70 percent of the flexible paved road worldwide. Nowadays, roadwork construction has made HMA as a choice of build material. The characteristic of HMA which is of affordable material cost and high performance made it as choice in road built. Even then, new improvements to achieve a quality HMA are done to tolerate the disadvantage of pavement which is deteriorating especially if the HMA structures are having continuous distress.

Years ago, Malaysia has come to realize that usage of conventional HMA which still are the choice of most road builder is not suitable for Malaysia. The nominal maximum size aggregates of 20 which is AC'W 20, is the most common used in road paving structure for its wearing course. Instead of using other nominal maximum size of aggregates, the choice of AC'W 20 as wearing course is because it is cheaper than the smaller nominal maximum size of aggregates being specified by JKR standards of wearing course.

2.1 Hot mix asphalt

HMA contains two important elements which are asphalt and aggregate material. Asphalt plays an important role of binding aggregates together in a HMA mixture. The largest particle acts and formed the skeleton of the aggregate structure which transfer the loads to the lower layer in pavement structure. The new JKR manual which was recently published had included the new specification for HMA mix. The introduction of porous asphalt, SMA and also polymer modified asphalt had widened the scope of road built in Malaysia. In order to achieve the desire in reducing maintenance cost and an effective pavement these new asphalt are to be believed a solution to some of the major problem faced in Malaysia.

2.2.1 Aggregate

Hot mix asphalt composes of aggregates and binder. The aggregate are based on gradation and is divided as coarse aggregates, fine aggregates and filler material which is based on the criteria set in JKR standards. The aggregate gradation is done by sieve analysis of the distribution of particle size by percentage retained. Where as, the grades of hot mix asphalt are determined based on its nominal maximum aggregate size (NMAS). Coarse aggregates are considered aggregates that are retain above 1.18mm sieve size where any particles passing it is considered as fine aggregates. Elsewhere, the filler material is the material that passes 75 micrometer sieve size that is obtained in the pan.

2.2.2 Filler material

Filler material in asphaltic concrete is an important element of bounding the aggregates and asphalt. The filler material that is usually used in asphalt pavement is of river sand, quarry dust or ordinary Portland cement (OPC). The filler is defined as the material that is retained in pan during sieve.

The mixtures of HMA are added with filler material which acts to bond aggregates and asphalt together. A hot mix asphalt properties consists of flow and stability, durability, flexibility, fatigue resistance, fracture strength, skid resistance, impermeability and workability. These properties are affected by the distribution of the aggregate, nominal maximum aggregate size (NMAS) and the binder content.

Mr. Chan, Manager of an established premix plant, said that the filler acts as a bondage material which to bond the aggregates and fills the pores in the mixture. Thus, to have better asphalt mixture, the filler material is changed with other material available such as ordinary Portland Cement (OPC), hydrated lime or carbide lime.

Normally, river sand is used as filler material because of the availability of the material and in terms of cost effectiveness. Other filler such as limestone also used in mixes. Nevertheless, filler material such as carbide lime from industrial waste could be proven as sufficient or more than capable of improving the normal mix HMA. Carbide lime or also known as calcium carbide is a product of excessive coke with quicklime in the presence of oxygen in an oxygen-thermal furnace. In studies and research that has been done before, mixes with carbide lime had shown