INFLUENCE OF FLAKY AGGREGATE TOWARDS CREEP AND RESILIENT MODULUS ON ASPHALT CONCRETE 20

MOHD ZUL HANIF BIN MAHMUD

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

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2013

Specially dedicated to my beloved father and mother,

Mahmud bin Doll and Begam binti Nebi

and my family,

Nur Faezah, Bibi Sygena, Bibita, Mohammed Gupta, Mohd Faisal and Nur Aliah Bazilah

THANK YOU

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and Most Merciful.

Alhamdulillah, praises to Allah for giving me the strength, patient, time and wisdom to complete this thesis. This long awaited moment seems like a dream to me. There have been many ups and downs while doing this project. Personally, I enjoyed the moment doing the data collecting and experiments. It seems like a huge challenge for me to choose the proper rock samples and doing the labs. I would give my sincere appreciation to my beloved family for believing in me to be who I am today.

My deepest appreciation goes to my supervisors, Dr. Haryati bte Yaacob and Dr. Ramadhansyah Putra Jaya for their guidance and help. Thank for all the criticism and shared experiences to help me prepare this thesis. I would also want to further my thanks to technicians of Highway and Transportation laboratories for their assistance and cooperation.

Last but not least, I would like to thank my friends that gave their support and ideas in this project and my time as a post-graduate student in UTM. May ALLAH reward all of them for their kindness and sincerity. All the helps and sacrifices from all parties are unforgettable and really appreciated. Hopefully one day, I may continue to my study to a higher level. InsyaAllah.

ABSTRACT

The aim of this paper is to investigate and evaluate the characteristics of flaky aggregate shapes that specifically towards creep and resilient modulus. The maximum allowable aggregate size selected specifically for this study is size 20 mm. In general, flakiness aggregates are being avoided in asphalt concrete mixture simply because these types of properties have significant influence of towards gradation and interlocking characteristic of the aggregate. Due to this significant influence of flaky aggregate, it is recommended that the proportion of flaky aggregate should be limited. Therefore, based on the Jabatan Kerja Raya (JKR) and Malaysian Standards (MS), it specified that the maximum allowable flakiness should be less than 25% in asphalt concrete mixture. This study is only focusing on asphalt concrete mixture that consists of 10%, 20% and 30% proportion of flaky aggregate. The objective of this study is to determine the relationship between resilient modulus against percentage of flaky aggregates in the asphalt concrete mixture. This study also looks on the influence different percentage of flaky aggregates towards dynamic creep properties in a mixture. Hence, several tests like Marshall Tests, Resilient Modulus test and dynamic creep test were conducted. Based on Marshall Tests, the optimum asphalt content obtained for 10%, 20% and, 30% was 5.6%, 5.7% and 5.8% respectively. The findings of this research are the value resilient modulus and stiffness modulus decreases as the amount of flaky aggregate increases.

ABSTRAK

Tujuan kertas kerja ini adalah untuk mengkaji dan menilai ciri-ciri bentuk batu baur yang berkeping khusus kepada daya tahan modulus dan rayapan. Saiz agregat maksimum yang digunakan dalam projek ini dipilih secara khusus adalah saiz 20 mm. Secara umum, batu baur perlulah dielakkan dalam campuran konkrit asfalt kerana batu baur mempunyai pengaruh yang signifikan ke arah penggredan dan sifat saling bertaut batu baur. Disebabkan oleh pengaruh ini, batu baur menjadi tidak stabil. Oleh itu, nisbah batu baur tidak stabil harus dihadkan. Berdasarkan kepada Jabatan Kerja Raya (JKR) dan Piawaian Malaysia (MS), penyerpihan maksimum yang dibenarkan hendaklah kurang daripada 25% dalam campuran konkrit asfalt. Kajian ini hanya memberi tumpuan kepada campuran konkrit asfalt yang terdiri daripada 10%, 20% dan 30% perkadaran batu baur berkeping. Objektif kajian ini adalah untuk menentukan hubungan antara daya tahan modulus terhadap peratusan batu baur yang berkeping dalam campuran konkrit asfalt. Kajian ini juga mengkaji pengaruh peratusan batu baur berkeping yang berbeza terhadap sifat dinamik rayap dalam campuran. Oleh itu, beberapa ujikaji seperti Ujian Marshall, Ujian Daya Tahan Modulus dan Ujian Rayapan Dinamik telah dijalankan. Berdasarkan Ujian Marshall, kandungan optimum asfalt yang diperoleh untuk 10%, 20%, dan 30% adalah masing-masing 5.6%, 5.7% dan 5.8%. Hasil kajian ini mendapati bahawa nilai daya tahan modulus dan kekakuan modulus berkurangan apabila jumlah batu baur yang berkeping bertambah.

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LIST OF ABREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
AC20	-	Asphalt Concrete Wearing With 20 mm Nominal Maximum Aggregate Size
ASTM	-	American Society for Testing and Materials
AASHTO	-	American Association of State Highway and Transportation Officials
BS	-	British Standard
HMA	-	Hot Mix Asphalt
JKR	-	Jabatan Kerja Raya
MS	-	Malaysian Standard
TMD	-	Theoretical Maximum Density
VTM	-	Void Ratio in Mix
VFA	-	Void Filled Asphalt
VFB	-	Void Filled Bitumen
OAC	-	Optimum Asphalt Content
OBC	-	Optimum Bitumen Content
g	-	gram
mm	-	millimetre
KPa	-	KiloPascal
MPa	-	MegaPascal
N	-	Newton
ºC	-	degree celcius
%	-	percent

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CHAPTER 1

INTRODUCTION

1.1 General

Aggregates are one of the major materials that are used in any road constructions. Generally, testing the properties of aggregates is one of the major concerns in asphalt industry because aggregates testing will give information about that particular research, design or mixture in order to implement quality control in any constructions projects. The aggregates samples that are tested will represent and reflects the average quality of the entire mass of the materials. For this paper, the major focus is to evaluate on the influence of flaky aggregate in an asphalt concrete mixture in terms of mechanical properties.

The shapes of the aggregates play a significant influence towards the performance of asphalt pavements. There are many shapes of aggregates. It can be classified as round, cubical, flaky, elongated, irregular and etc. For road construction, the shapes of flaky aggregates are commonly undesirable and therefore the amount flaky aggregate should be limited. Research have indicates that aggregate testing towards the characteristic like particle size, shapes and texture will influence the performance and life span of the asphalt pavement (Brown *et al.* 1989). According to the Malaysian Standards (MS 30) manuals, the amount of maximum flakiness allowed can be varies from 25 % to 30 % depending on the type of road layers. For asphalt concrete, the maximum amount of flaky aggregate allowed is 25%.

1.2 Problem Statement

Aggregate shapes play a significant role influencing the performance of asphalt concrete mixture since 95% of the composition of hot mix asphalt is consist by mineral aggregate. The shapes of the aggregates that are used in many constructions can be rounded, irregular, angular, flaky, elongated and also a combination of flaky and elongated. In most road construction, flaky and elongated aggregates are undesired shaped since these types of aggregate have higher chances to be broken once the road constructed and opened to public. Oduroh et al. (2000) described the orientation of the flaky and elongation shape of the aggregate in an asphaltic mixture creates lower resistance towards shear deformation and thus, creates problems like premature failure and decreasing the performance of the pavement.

It is understood that flexible pavement is the most common type of pavement used in the world. According to Satyakumar & Wilson (2009), most of the authorities used Marshall Tests to judge the mechanical properties asphalt mixture which is used in pavement design. They continue to explain that the value of Marshall Tests cannot be directly used in pavement design calculation due to the increase traffic demand and load. It is important to understand the mechanical properties to measure resistance to deformation and failure. One of the tests to measure flexibility of asphalt mixture is through Resilient Modulus (M_R) test. This test is being carried out using universal testing machine to understand the effectiveness of the elastic properties of the mixture of asphalt under repeated loading. Erol *et. al*. (2005) discussed in his study that by using a more irregular morphologies can improve the resilient modulus of the bituminous mixture. For this study, the second type of mechanical testing for asphalt pavement is creep test. This test is to measure time dependent deformation under constant compressive stress for the asphalt concrete mixture.

1.3 Objective of Research

The main aim of this research is to investigate the influence of different proportion of flaky shape aggregates in terms of mechanical properties for an asphalt concrete mixture for size 20 mm (AC 20). The objectives of this study are also listed below;

(i) To determine the relationship of different percentage of flaky aggregates towards the resilient modulus properties in an asphalt concrete mixture;
(ii) To investigate the influence different percentage of flaky aggregates towards dynamic creep properties in an asphalt concrete mixture.

1.4 Scope of Study

The scopes of study on this research are focusing on the influence flaky shape aggregates towards creep and resilient modulus for an asphalt concrete mixture. The scope of study is listed as follow;

i. This study is focused on asphalt concrete size 20 mm (AC 20);

ii. This research involved different proportion of 10%, 20% and 30 % flaky shapes aggregate in an asphalt concrete mixture;

iii. The scope of this study for this project are involved with the influence of exceeding the maximum allowable proportion of 25% of flaky shapes aggregate in an asphalt concrete mixture;

iv. For this study, the laboratory tests that are conducted to obtain the objective of this research i.e. Marshall Tests, indirect tensile test and dynamic creep test.

1.5 Significance of Research

This study will help to develop an understanding toward the influence different shapes aggregates in an asphalt concrete mixture in Malaysia. Below are the other significant influences towards this research:

(i) To understand the behaviour of different proportion flaky shapes aggregate based on resilient modulus and stiffness modulus in an asphalt concrete mixture;

(ii) To assist in improving better understanding of proper shapes of aggregates in order to provide a more sustainable pavement development in Malaysia.

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