

**INFLUENCE OF AGGREGATE FLAKINESS ON MARSHALL
PROPERTIES FOR ASPHALTIC CONCRETE (AC14) MIXTURES**

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Dedicated to my beloved father and mother, Jarkasi Bin Mohd Yassin
and Kadinam Bt Kadimon, all my sister and brother
(Haliza, Harlina, Hanitah, Anuar, Siti Khadijah, Ismail and Sulaiman)
for their love, support and patience”

“Also not forgotten to all my friends, thank you for encouragement,
support and help”

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ABSTRACT

Flaky aggregate is normally avoided in bituminous mixtures because it influences the aggregate gradation, reduces interlocking characteristics and due to that it should be therefore limited. This thesis presents a study of laboratory evaluation on the effects of flaky aggregates in asphaltic concrete, AC14. Three types of proportion flaky aggregates in the mixture were considered under this study which 8 percent, 16 percent and 24 percent. Laboratory Marshall Mix Design System was used for all mix design. The objective of this study is to study the effect of flaky aggregates on the optimum bitumen content and Marshall Properties of AC14. Flow and stability (ASTM D 1559-89) test was used in this study to determine the value for all parameters needed. It is found that bitumen content will increase with increase the proportion use of flaky aggregates in the mixture. Besides that, the value of Marshall Properties for AC14 such stability, VTM and stiffness are reduced with increase the flaky aggregate content while, the value of flow and VFA is increased. As a conclusion, the presence of flaky aggregate is affected the asphalt content and Marshall Properties for AC14 mix.

ABSTRAK

Penggunaan agregat yang berkeping biasanya dielakkan di dalam Campuran asfalt kerana ia mempengaruhi penggeda agregat, serta mengurangkan ciri-ciri saling mengunci antara agregat dan disebabkan itu penggunaanya perlu dihadkan. Tesis ini membentangkan tentang kajian penilaian makmal terhadap kesan penggunaan agregat berkeping di dalam campuran konkrit berasfalt, AC14. Tiga jenis kandungan agregat berkeping yang digunakan di dalam kajian ini iaitu 8 peratus, 16 peratus, dan 24 peratus. Setiap campuran direkabentuk menggunakan sistem campuran Marshall. Objektif kajian ini adalah untuk mengkaji kesan agregat berkeping terhadap kandungan asfalt dan ciri-ciri Marshall bagi campuran AC14. Ujian kestabilan dan Aliran telah digunakan di dalam kajian ini untuk menentukan nilai bagi parameter yang diperlukan. Daripada ujian yang dijalankan, didapati bahawa kandungan optimum asfalt meningkat dengan meningkatnya penggunaan agregat Berkeping di dalam campuran konkrit berasfalt. Selain itu, nilai kestabilan, peratus lompong di dalam campuran dan kekukuhan berkurangan dengan peningkatan penggunaan agregat Berkeping manakala nilai Aliran dan peratus lompong terisi asfalt meningkat. Kesimpulannya, penggunaan agregat berkeping memberi kesan terhadap kandungan asfalt di dalam campuran konkrit berasfalt dan ciri-ciri Marshall.

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LIST OF ABBREVIATIONS

AC14	-	Asphaltic Concrete Wearing with 14 mm Nominal Maximum Aggregate Size
HMA	-	Hot Mix Asphalt
OAC	-	Optimum Asphalt Content
SHRP	-	Strategic Highway Research Program
ASTM	-	American Society for Testing and Materials
JKR	-	Jabatan Kerja Raya
PCC	-	Portland Cement Concrete
FI	-	Flakiness Index
BSI	-	British Standard Institution
FHWA	-	Federal Highway Administration
VMA	-	Voids in Mineral Aggregate
VFA	-	Voids Filled with Asphalt
VTM	-	Voids in Total Mix
AASHTO	-	American Association of State Highway and Transportation Officials
AIV	-	Aggregate Impact Value
TMD	-	Theoretical Maximum Density
ANOVA	-	Analysis of Variance

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Road as one of land transportation infrastructure is very important in supporting the economic for both regional and national development. A good and systematic of road network can make the short travel time from one destination to other destination. In 2008, there are approximately 90, 000 km of roads in Malaysia and it is about 87, 626 km are paved with asphalt (Hainin, *et al*, 2010). The road has specific design life based on the traffic loading that has been determined before construction.

The quality of material for road construction will influence the road performance. Asphalt concrete as one of road surface material is mainly influenced by the quality of aggregates since aggregate occupies 95 percent by weight in total mixture (Ginting, *et al*, 2005). Various shapes of aggregates might be occurred during crushing in the crushing plant starting from rounded to flaky and elongated aggregates. The presence of flaky aggregates is considered undesirable in bituminous mixtures because of their tendency to break down during construction and subsequent traffic operations.

Poor quality of materials will lead to damaged road. The damaged road should be repaired to prevent an accident by road users. Therefore, aggregate shape is one of the important properties that must be considered in the mix design of asphalt pavements to avoid premature pavement failure.

1.2 Problem Statement

Mineral aggregate has contributed approximately 95 percent of hot mix asphalt (HMA) by weight. The mineral aggregate is made up predominantly of coarse aggregate. Some study have been done shown that aggregate characteristic such as particle size, shape, and texture influence the performance and service ability of road pavement (Brown, *et al*, 1989).

Cubical particles were desirable for increased aggregate internal friction and also improved rutting resistance. The usage of flaky aggregates in bituminous mixture is undesirable because of their tendency to break down during construction and subsequent traffic operations. In addition, bituminous mixture which consist high flaky aggregates has more voids and the workability of the mixtures is low.

Flaky particles have less strength and durability when compared with cubical, angular or rounded particles of the same aggregate. Hence too flaky aggregates should be avoided as far as possible in the bituminous mixtures. There are some study which conducted by Li and Kett (1967) found that mixes with flaky aggregates have exhibit higher fatigue life and mixes with non flaky aggregates.

The presence of flaky aggregates beyond certain limits will reduce the strength of bituminous mixtures and causes extreme damage in road pavement. Their presence in large proportions also results in a higher asphalt demand due to the increased surface area. Hence, it was felt need some study to find the right proportions of flaky and elongated aggregates used in bituminous mixtures.

1.3 Objectives of Study

Objectives are good guidelines for the development of study so that it can be developed according to the correct direction in the future. There are several objectives that have been highlighted in this study.

- 1) To determine optimum asphalt content (OAC) for AC14 based on the proportion of flaky aggregates.
- 2) To study the effect of flaky aggregate on the volumetric properties of asphalt mix.
- 3) To develop a relationship between different proportion of flaky aggregate and Marshall Characteristics for AC14.

1.4 Scope of Study

This study will be focused on the effect of flaky aggregates of asphaltic concrete with 14 mm nominal maximum aggregate size, AC14 towards the stability of the bituminous mixtures. The proportion of flaky and elongated aggregates used in the mixtures is 8 percent, 16 percent, and 24 percent. The asphalt that use for AC14 is PEN 80/100.

All of the samples are Marshall Samples. The test that will be conducted to measure the stability of the bituminous mixtures is Marshall Stability Test. From the test, the parameters value of Marshall Properties will be known and comparison will be making between each sample that contain different proportion of flaky aggregates.

1.5 Significant of Study

From the study, all the parameters value of AC14 with different proportions of flaky aggregates can be obtained. It is important to know the effect of flaky aggregates towards the Marshall properties and to what percentage should flaky aggregates limited for AC14 to meet JKR specification. Last but not least is the result of this study can be used for further study on the effect proportions of flaky aggregates in HMA mixtures in Malaysia.

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