

PROPERTIES OF ASPHALTIC CONCRETE AC14 CONTAINING COCONUT  
SHELL AS COARSE AGGREGATE

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*To my beloved mother and father*

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## ABSTRACT

Nowadays, there are various researches that using waste materials as materials substitute. This is to produce a green and sustainable environment and at the same time to solve the main problem which is to reduce the waste materials. Pavement engineering is one of the fields that can contribute to solve this problem where the use of waste materials in pavement can be an alternative to reduce the waste materials, protect the environment, reduce the extraction of aggregates and at the same time to improve the quality of pavement. Various of researches have been done by using industrial and construction waste material as aggregates replacement in asphalt concrete. Recent studies have shown the successful of using agricultural waste material in concrete. However the use of agricultural waste in asphalt concrete has not been extensively studied. Hence, in this study the effects of coconut shell as coarse aggregate replacement in properties of asphaltic concrete AC14 was investigated. The aggregate properties tests, Marshall Mix design, resilient modulus, indirect tensile strength and dynamic creep test were examined. 5 mm size of coconut shell was used as coarse aggregates replacement at 10%, 20%, 30% and 40%. The result shows that coconut shells modified samples had less stability compare to the control samples due to effects from the volumetric properties. Nevertheless, the sample contained 10% replacement of coconut shells showed higher resistance to deformation in comparison to control sample. It can be concluded that, 10% replacement of coconut shell in asphaltic concrete was suggested in modifying the samples.

Elements of Abstract	Checked
1. Background	
2. Objective	
3. Methodology	
4. Results	
5. Conclusion	
6. Grammar and flow	
Supervisor Signature & Date:	

## ABSTRAK

Pada masa kini , terdapat pelbagai kajian yang menggunakan bahan-bahan buangan sebagai bahan pengganti . Ini adalah untuk menghasilkan persekitaran yang hijau dan mampan dan pada masa yang sama untuk menyelesaikan masalah utama iaitu untuk mengurangkan bahan-bahan buangan . Kejuruteraan turapan jalan adalah salah satu bidang yang boleh menyumbang kepada menyelesaikan masalah ini di mana penggunaan bahan-bahan buangan boleh menjadi alternatif untuk mengurangkan bahan buangan , melindungi alam sekitar, mengurangkan pengeluaran agregat dan pada masa yang sama untuk meningkatkan kualiti turapan . Pelbagai kajian telah dilakukan dengan menggunakan bahan industri dan sisa pembinaan sebagai pengganti agregat dalam konkrit asphalt . Kajian telah menunjukkan kejayaan menggunakan bahan sisa pertanian dalam konkrit . Walau bagaimanapun penggunaan sisa pertanian dalam konkrit asphalt belum dikaji secara meluas . Oleh itu , dalam kajian ini kesan tempurung kelapa sebagai pengganti agregat kasar dalam sifat AC14 konkrit asphalt telah disiasat . Ciri-ciri ujian agregat , rekabentuk campuran Marshall, modulus berdaya tahan, kekuatan tegangan tidak langsung dan ujian rayapan dinamik telah diperiksa . Saiz 5 mm daripada tempurung kelapa digunakan sebagai agregat kasar gantian pada 10 % , 20 % , 30 % dan 40 % Hasilnya menunjukkan bahawa sampel tempurung kelapa diubahsuai mempunyai kestabilan yang lebih tinggi berbanding sampel kawalan disebabkan oleh kesan dari sifat-sifat isipadu . Walau bagaimanapun, sampel yang terkandung 10 % penggantian daripada tempurung kelapa menunjukkan rintangan yang lebih tinggi untuk ubah bentuk dalam perbandingan untuk mengawal sampel . Ia boleh disimpulkan bahawa , penggantian 10 % daripada tempurung kelapa dalam konkrit asphalt dicadangkan dalam mengubah sampel .

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background of Study**

The land area of Malaysia is about 328, 550 km<sup>2</sup> which are comprises of peninsular Malaysia and East Malaysia (UNDP, 2014). The population is about 27 million which keep on increasing each year. Apart from that, Malaysia is middle income country which undertaken multi-sector economy and one of the significant economic providers come from natural resources in areas such as agriculture, forestry and minerals. Due to that, not only the solid waste is produces from the high population but also the industrial and agricultural waste leads to environmental problem. Therefore, one way to solve the environmental problem due to the waste material is to reuse or recycling the waste.

Pavement engineering is one of the areas that can contribute to solve the problem of the waste material which can lead to environmental problem. Various of studies have been carried out to improve the quality of pavement where one of the mostly conducted research is the utilization of waste materials in asphaltic concrete. Research into new and innovative uses of waste materials become more advance where more research of agricultural waste as aggregates in engineering sector is carried out by the researchers. Many past researches used the waste material such as tyres, glasses, plastics, recycled concrete and fly ash as material replacement. Meanwhile, agricultural waste such as oil palm shell, coconut shell, rice husk, corn cob and others have shown successfully used as aggregates replacement in concrete.

The use of agricultural waste not only help to reduce the waste material but also help to save the environment by making the industry become more sustainable and environmentally friendly.

ASTM Designation 8 defined aggregate as a granular material of mineral composition such as sand, gravel, shell, slag or crushed stone used with a cementing medium to form mortars or concrete or alone as in base courses, railroad ballasts, etc. (Asphalt Institute, 1989). Aggregate comprises of natural aggregates, processes aggregates and artificial aggregates. Natural aggregates are obtained by extract from larger rock either by blast or dig from the quarry (Pavement Interactive, 2008). Gravel and sand are example of natural aggregates. Processed aggregates are the crushed and screened of natural gravel or stone meanwhile artificial aggregates are produced from the physical and chemical changes (Asphalt Institute, 1989).

Aggregate is the largest composition in the asphalt concrete mix design apart from bitumen and filler. Aggregate contributes about 90 to 95% by weight or 75 to 85% by volume of asphalt concrete mix (Asphalt Institute, 1989). Highways in Malaysia consist of paved road for about 116 169 km while unpaved road is 28 234 km (The World Factbook, 2014). Other than that construction of local two lane highway can consumes over 15,000 tonnes of aggregates per kilometre (ECO Annual Report, 2003).

Apart from that, aggregate not only required in construction of roads and highways but also in maintenance and rehabilitation of roads where in Malaysia the cost for road maintenance is higher than the cost for construction of new roads. Hence, it can be seen that large quantity of aggregate is needed in road construction and it is not include consumption of aggregate from other industries yet. Thus, more aggregates need to be extracted from the natural sources. Unfortunately, extraction of the natural sources will keep on increasing which lead to decreasing in natural sources and affect the environment. As a result, other resources of aggregate need to be searched and more cost will be needed.

## **1.2 Problem Statement**

From the background of the study, several problems are pointed out which are to improve the quality and performance of pavement where road damages and deterioration always occur. Next is increasing of agricultural waste due to increasing of high population which leads to environmental problem. Apart from that, high demand of aggregate from different sectors will lead to depletion of natural mineral sources.

Hence, by considering the engineering, environmental and economic factor, the waste materials can be reduce, help protect the environment, reduce aggregate extraction and preserve the natural sources, reduce the materials costs, improve the quality of pavement and produce sustainable pavement. Due to that, more research is required by using waste material as aggregate replacement in asphaltic concrete. However, little study conducted using coconut shell as aggregate replacement in asphaltic concrete. Thus, in this study, coconut shell is used as coarse aggregate replacement in asphaltic concrete.

## **1.3 Objectives**

The objective of this study as follow:

- a) To study the effects of coconut shell on the engineering properties of asphaltic concrete containing coconut shell
- b) To determine the optimum percentage replacement of coconut shell as coarse aggregate in asphaltic concrete

#### **1.4 Scope of Study**

This study was focused on the use of coconut shell as coarse aggregate replacement in asphaltic concrete. The type of mix used in this study was AC14 which means the nominal maximum aggregate size is 14 mm which passing 20 mm sieve. Besides that, the size of coconut shell used was 5 mm size and replaced 10%, 20%, 30% and 40% of aggregates in the mix. Only one value of OBC was used in all the modified samples. The test carried out include the specific gravity (SG) and water absorption (WA), aggregate impact value (AIV), Marshall Test analysis, resilient modulus test, indirect tensile strength and dynamic creep test. All the tests were carried out according to the standard and specification of JKR standard (JKR/SPJ/2008), American Society for Testing and Materials (ASTM) and British Standards European Norm (BS EN) respectively.

#### **1.5 Significance of Study**

This study is carried out to investigate the effects of using agricultural waste material which is coconut shell to replace coarse aggregate in asphalt concrete. There are three significant factors based on this study which are engineering factor, environmental factor and economic factor. In engineering factor, if the use of coconut shell is compatible then it could be an alternative to replace the high demand of aggregate from various sectors where it is a finite natural source which can deplete in the future time and shortage of aggregate leads to another problem. Besides that sustainable development could be produced from this alternative due to the use of agricultural waste material that would help the environmental factor by reduce the disposal of agricultural waste materials and protect the environment. Last but not least is the economic factor. The cost of construction of roads could be reduced due to no extracting of aggregates which required costs of workers, transportation and so forth.

## **1.6 Limitation of Study**

This study emphasises on the use of coconut shell as coarse aggregate replacement in asphaltic concrete. The size of 5 mm coconut shell was used as aggregate replacement. The time is limited because the fibers of the coconut shell need to be remove and this process require about a month. Thus only one value of OBC was used for all the percentage replacement of modified sample.

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