

EFFECT OF FINENESS COCONUT SHELL CHARCOAL ASH ON THE
RHEOLOGICAL PROPERTIES OF BITUMEN

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A project report submitted in partial fulfilment of the
requirement for the award of the degree of
Master of Engineering (Transportation)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2016

To my beloved father and mother

ACKNOWLEDGEMENT

I would like to take this opportunity to express my sincere gratitude to all those who have contributed in completing my master project.

First of all, i would like to deeply praise to Allah SWT for the blessing and for allowing me passing all this moment and complete this report in time and presentably. I would like to express my sincere appreciation to my supervisor, Dr. Ramadhansyah Putra Jaya and to my co-supervisor Dr. Azman Mohamad for the encouragement and guidance throughout every step of my study and generously shared their time and knowledge with me.

My special thanks to technical staff members at Highway and Transportation Engineering Laboratory at UTM for their assistance while carrying out my laboratory work. My sincere appreciation to my family and fellow friends who showed their concern and support all the way.

ABSTRACT

In recent years, a problem regarding environmental pollution due abundance waste from agricultural activities increased due to higher productivity. An approach is taken to solve this problem by recycle this agricultural waste. Coconut shell charcoal (CSC) ash is a by-product of coconut shell that is used as bitumen modifier to enhance properties of binder. This paper aims to study the effect on rheological properties of binder at different fineness of CSC. Penetration test, softening point test and viscosity test were performed to determine properties of modified bitumen. Laboratory simulation of short term aging called RTFO test was applied in this study. To conduct the test, CSC was grind for three hours then sieve to obtain different sizes. CSC at three different sizes (less than 75 μ m, 75-150 μ m, and 150-300 μ m) was added to replace bitumen 60/70 PEN at 10%, 15% and 20% by weight of bitumen. The result of the study shows that bitumen become more viscous and softening point of bitumen increased while rate of penetration decrease when incorporating with CSC. It is also noted that proper amount of CSC have improved resistance to temperature susceptibility. The result also indicates that modification of bitumen can relieve the effect of aging. Modified bitumen shows better result when incorporating with the finest particle (less than 75 μ m) of CSC compare to other sizes.

ABSTRAK

Beberapa tahun belakangan ini, aktiviti pertanian telah menyebabkan pencemaran alam sekitar oleh kerana pembakaran bahan buangan. Bagi mengatasi masalah ini, sisa pepejal hasil daripada aktiviti pertanian telah dikitar semula. Arang tempurung kelapa (ATK) merupakan hasil daripada tempurung kelapa yang digunakan sebagai bahan pengikat untuk meningkatkan sifat-sifat bitumen. Penyelidikan ini bertujuan untuk mengkaji kesan kehalusan arang tempurung kelapa terhadap sifat reologi bitumen. Ujian penusukan, titik lembut serta ujian kelikatan telah dijalankan untuk menentukan sifat-sifat bitumen yang diubahsuai. Ujian RTFO telah dijalankan untuk mengetahui kesan penuaan jangka pendek terhadap bitumen. Sebelum ujian makmal dijalankan, ATK telah dikisar selama tiga jam dan kemudiannya diayak untuk mendapatkan tiga saiz yang berbeza (kurang daripada $75\mu\text{m}$, $75-150\mu\text{m}$, dan $150-300\mu\text{m}$). ATK telah ditambah untuk menggantikan bitumen 60-70 pada kadar 10, 15 dan 20% daripada berat bitumen. Keputusan menunjukkan bitumen yang diubahsuai menjadi semakin likat, titik lembut bitumen juga meningkat manakala kadar penusukan telah menurun. Peratusan gantian ATK yang bersesuaian dapat meningkatkan rintangan terhadap kecenderungan suhu. Hasil kajian juga menunjukkan bitumen yang diubahsuai dapat mengurangkan kadar penuaan. Bitumen diubahsuai menunjukkan keputusan yang lebih baik apabila diganti dengan zarah ATK yang paling halus (kurang daripada $75\mu\text{m}$) berbanding dengan saiz zarah ATK yang lain.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Over the past decades, many researches were carried out to study the effect of natural additives on the properties of conventional bitumen. This concept of modifying bitumen is not new. In fact, numerous studies were done all over the world to modified bitumen using mineral additive in order to get a better properties of bitumen and to enhance performance of asphalt mixture. Nowadays, the used of coconut shell as a modifier in bitumen or replacement of aggregate in asphalt mixture are getting more attention among researchers. However in Malaysia, the application of charcoal from coconut shell as modifier in bitumen is not significantly enough. This is due to less number of researches conducting study on potential of coconut shell used as bitumen modifier in order to improve their properties.

Normally, the selection of bitumen grade is based on climate of the proposed location. For hot country climate, harder grade of bitumen is preferred while softer grade is suitable for cold country climate. Some bitumen requires modification in order to meet specification. However, not all modifiers appropriate for all application because each mineral modifier have its own chemical composition. Generally, bitumen should be modified to reduce temperature susceptibility and improve adhesive and cohesive. Therefore, it is expected that this practice will not only give

significance impact in recycling agricultural waste material but also have potential to reduce the cost and improve the performance of bitumen.

1.2 Problem Statement

There are huge amount of existing waste material from industrial, domestic and agricultural activity that create disposal problem all over the world. In Malaysia, agricultural sector plays an important role in Malaysia's economic development. Malaysia produces a substantial amount of agricultural waste every year especially from rubber plantation, palm oil plantation and also coconut plantation. Recently, coconut shell has become popular ingredient in asphalt mixture but still they are often ignored and treated as agricultural waste. Usually after coconut flesh being extract, then the hard shell will be throw away due to high cost needed to dispose their waste product in dumping site. This is the common problem arising from agricultural wastes which eventually cause adverse impact to our environment due to waste disposal problem.

Apart from that, conventional bitumen used in most countries hardens at earlier stage during handling, mixing, and service. Bitumen also not perform well especially when exposed to extreme hot and cold temperature. It is easily to become soft at high temperature and brittle at low temperature due to aging process. This rheological weakness of conventional bitumen has generated an increasing interest among researcher in the used of other mineral additive to modified bitumen in order to enhance the properties of conventional bitumen.

Besides that, the price of conventional bitumen in Malaysia keeps increasing every year. High price of bitumen will affect cost of road construction. Currently, the cost of road construction for state road and federal road is more or less than RM 1 million per kilometer ("Transport Malaysia," 2014). Bagui and Ghosh (2012) state that construction cost using polymer modified bitumen is less than conventional bitumen. Hence, this study is to investigate the effect of coconut shell charcoal (CSC) on the rheological properties of bitumen. It is still unsure either CSC as modified bitumen is economically and financially viable or not to be used as modified bitumen.

1.3 Objective of Study

The objectives of this study are;

1. To investigate the effect of coconut shell charcoal at different fineness on the rheological properties of bitumen.
2. To determine the optimum content of coconut shell charcoal as modified bitumen.

1.4 Scope of Study

This study cover on topic modified bitumen with different fineness of coconut shell charcoal by using wet process. In this study, the scope focus on bitumen with penetration grade 60/70 PEN since this grade is recommended in new JKR Standard Specification for Road Works (2007). Coconut shells were burnt about five minutes at 450 °C to obtained coconut shell charcoal. In this study, three different sizes of CSC ash were used namely CSC-1 (size less than 75 µm), CSC-2 (75-150 µm) and CSC-3 (150-300 µm). The data was analyzed by comparing the result of each test that was conducted. All the tests and laboratory work were performed at Highway and Transportation laboratory, Faculty of Civil Engineering, UniversitiTeknologi Malaysia.

1.5 Significant of Study

This study focuses more on using local by product from agricultural crop as an additive to modify bitumen. Instead of using other material export from outside, coconut shell also show significant capability to modify bitumen in order to enhance its properties. Besides that, this study helps to provide more reliable and valid data from experimental work since less research done on coconut shell as modifier in bitumen. Information and data from this study can use for future study and might helps authority to establish specification to modified bitumen using coconut shell charcoal for road construction. In addition, the cost of constructing flexible pavement can be reducing since waste material is used as modifier in bitumen to improve the performance of road.

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