

**THE EFFECT OF RUBBER DIPPING BY-PRODUCT ON BITUMEN
PROPERTIES**

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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

Dedicated to my beloved parents
Haji Mohamad Khalid Omar and Hajah Rokiah Abu Bakar
For their love, care, support and patience..

ACKNOWLEDGEMENT

In the name of ALLAH SWT, with His blessings and giving me strength to complete my master's project in a timely manner. I am very thankful for people around me who has contributed to the completion of my project.

First and foremost, I would like to express my sincere thanks and appreciation to my project supervisor Tuan Haji Che Ros bin Ismail, who continuously guided me throughout every step of my study and generously shared his time and knowledge with me.

My special thanks must be extended to technical staff members at the Highway and Transportation Engineering Laboratory at UTM especially to Encik Azri for collaboration and assistance while carrying out my laboratory work. Also to other individuals who have contributed to the success of this project whether directly or indirectly.

I shall remain indebted to my beloved parent, brother and sisters for their love, constant care and encouragement during the course of my master's project. Thank you so much and I will always love you.

ABSTRACT

Nowadays, there a lot of damaged of road pavement and it become a very serious issue in Malaysia. To minimise the damage of pavement surface and increase durability of flexible pavement, the conventional bitumen needs to be improved with regards to performance related properties. Thus, this study presents of the effect of rubber dipping by-product (RDP) on bitumen properties. RDP is waste material from natural rubber industrial and it is in solid forms. Bitumen grade 80/100 PEN was used in this study. The bitumen was modified with varying percentages of RDP; 0% for control sample, 5%, 10%, 15% and 20% by the total weight of the bitumen with mixing temperature of 180°C, mixing time of 60 minutes and mixing speed of 800rpm. Laboratory tests carried out were penetration, softening point, viscosity, rolling thin film oven (RTFO) and pressure aging vessel (PAV) test based on the ASTM standard. From the result of penetration, viscosity, PI, and PVN in this study, the RDP modified bitumen led to improve bitumen resistance to oxidative aging because addition of RDP increases bitumen properties after RTFO and PAV test compared to unmodified bitumen. Moreover, the additive of RDP can be increased of temperature susceptibility and increased viscosity properties. The findings from laboratory's result show that sample with 10% RDP performed better compared to other percentages.

ABSTRAK

Kini, terdapat banyak kerosakan turapan jalan raya dan ia menjadi satu isu yang sangat serius di Malaysia. Bagi meminimumkan kerosakan permukaan turapan dan meningkatkan ketahanan turapan fleksibel, konvensional bitumen perlu dipertingkatkan dari segi sifat-sifat ketahanan. Oleh itu, kajian ini membentangkan kesan produk sampingan getah celupan (RDP) ke atas bitumen. RDP adalah bahan buangan dari industri getah asli dan ia adalah dalam bentuk pepejal. Bitumen gred 80/100 PEN telah digunakan dalam kajian ini. Bitumen diubahsuai dengan peratusan RDP yang berbeza-beza; 0% bagi sampel kawalan, 5%, 10%, 15% dan 20% dari jumlah berat bitumen dengan suhu pencampuran 180°C, selama 60 minit dan dengan kelajuan 800 rpm. Ujian-ujian makmal yang telah dijalankan ialah penusukan, ujian titik lembut, kelikatan, ujian *rolling thin film oven* (RTFO) dan ujian *pressure aging vessel* (PAV) yang berdasarkan standard ASTM. Dari hasil ujian penusukan, kelikatan, PI, dan PVN dalam kajian ini, pengubahsuaian bitumen dengan RDP meningkatkan ketahanan bitumen bagi mengatasi oksidatif penuaan kerana kandungan RDP telah meningkatkan sifat-sifat bitumen selepas ujian RTFO dan PAV berbanding dengan bitumen biasa tanpa pengubahsuaian. Walau bagaimanapun, penambahan RDP telah menunjukkan suhu yang tinggi dan sifat kelikatan meningkat terhadap bitumen. Berdasarkan keputusan makmal, sampel yang telah ditambah dengan 10% RDP menunjukkan prestasi yang lebih baik berbanding peratusan lain.

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LIST OF ABBREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society for Testing and Materials
BBR	-	Bending Beam Rheometer
DSR	-	Dynamic Shear Rheometer
DDT	-	Direct Tension Tester
EVA	-	Ethylene Vinyl Acetate
JKR	-	Jabatan Kerja Raya
MS	-	Malaysian Standard
NR	-	Neutral Rubber
PAV	-	Pressure Aging Vessel
PE	-	Polyethylene
PI	-	Penetration Index
PVN	-	Penetration Viscosity Number
RDP	-	Rubber Dipping By-Product
RPM	-	Revolution per minute
RTVO	-	Rolling Thin Film Oven
RV	-	Rotational Viscometer
SBS	-	Styrene Butadiene Styrene
g	-	gram
mm	-	millimetre
N	-	Newton
°C	-	degree celcius
%	-	percent

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

When the need for paved roads became a worldwide requirement, bitumen appeared very quickly as an ideal binder to build both the pavement structure and the wearing course. At high temperatures, bitumen due to its viscous behavior can be mixed with aggregate to manufacture asphalt concrete, which remains sufficiently workable during placement and compaction. At ambient temperatures, bitumen behaves as a visco-elastic material providing both stability and flexibility which present as essential properties for long lasting pavements (Sengoz and Isikyakar, 2007).

Conventional bituminous material had their performance which can give satisfaction in highway pavement construction. However, increasing of traffic volume, heavier and larger truck which are greater than design load on the pavement and increasing of tire pressure contribute to damage of pavement and it will shorten the life span of the pavement.

One step ahead is needed to minimize this major problem in road pavement. Bituminous layers should be improved to make it long lasting with slightly maintenance and comfort to the end user. Thus, this study come out to increase quality of bitumen by using waste material which can save environment from pollution and it will become cost effective for raw material usage.

There are many waste materials that can be used as an additive which can increase strength of the bitumen. Waste material used in this study is rubber dipping products or known as RDP and it was mixed with bitumen grade 80/100 PEN. The application of natural rubber by mixing with asphalt materials in roadwork is an alternative material that may help to increase the quality of road pavement, extent service life of the road and reduce expenditures in maintaining road pavement.

1.2 Problem Statement

Road pavement conditions can be too sensitive when constructed not according to the standard provided by Jabatan Kerja Raya (JKR). Main reasons for this problem occurred are low quality of bitumen used, inappropriate grade of bitumen used and raw material like aggregate used are not follow to the standards. Nowadays, there a lot of damaged of road pavement and it become a very serious issue in Malaysia. Damaged pavement will cause accident to the road user especially motorcyclist. This is because problematic pavement that appears on the surface of the road such as potholes, crocodile crack and other surface defects of asphalt pavement can act like a trap which can endanger the road user. Thus, maintenance of road and also vehicle cost can increase too. Road pavement construction will be expanding due to development in Malaysia so the physical properties of bituminous material need to improve and it can prevent from pavement failure which can minimize maintenance cost.

Nowadays, global warming becomes a big issue and all over the world faces the climatic problem, flood, tornado and landslides. Pollution was the big contribution to this global warming issue. Waste materials which need more than a year to decompose can cause land pollution. These materials need incinerator to dispose which need more cost or recycle and reuse the waste and it will save cost immediately. There are many waste material produced according to economic development and new invention adopted from other country. Rubber dipping by-product (RDP) was used as bitumen modifier to strengthen the bituminous material and it is very useful to the highway construction. The use of waste material such as rubber can be a good alternative and it can decrease construction cost of pavement. This study was carried out to investigate the optimum percentage of RDP to be mixed with bitumen.

1.3 Aim and Objectives

The aim of this study was to investigate the properties of rubber dipping by-products modified bitumen using bitumen grade 80/100 PEN compared to non-modified bitumen of grade 80/100 PEN. In order to achieve this aim, the objectives of this study are:

- i. To determine the effect of RDP in different concentration on bitumen properties.
- ii. To compare non-modified bitumen with modified bitumen in terms of their characteristics.

1.4 Scope and Limitation of the Study

In order to ensure that the study conducted will achieve the aim and objectives, the scope of study was focused on properties of modified bitumen compared to non-modified bitumen. Bitumen grade 80/100 PEN was used which was provided by Highway and Transportation Laboratory of Civil Engineering Faculty, Universiti Teknologi Malaysia and by-products of rubber dipping in granular forms were supplied by Synthomer Company from Kluang, Johor. Number of samples to be prepared includes five different percentage of RDP mixed with bitumen in 5 different percentages mixing; 0%, 5%, 10%, 15% and 20% of total weight of bitumen used and temperature used during mixing process is 180°C. The mixing time and mixing speed were fixed of 60 minutes with 800 rpm for each mixing process.

Laboratory test was conducted on every sample in this study were penetration, softening point, viscosity for different aging, rolling thin film oven (RTFO), and pressure aging vessel (PAV) based on ASTM and AASHTO. All laboratory test listed were conducted in the Highway and Transportation Laboratory of Civil Engineering Faculty, Universiti Teknologi Malaysia.

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