THE EFFECT OF AGING ON ASPHALT MIX

ALI MOGHADDASI

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

Faculty of Civil Engineering

Universiti Teknologi Malaysia

January 2013

This project report is dedicated to my beloved mother and father for their endless support and encouragement.

ACKNOWLEDGMENT

I would like to express my gratefulness to all entities that are involved in my project work. In preparing this thesis, I was in contact with many people, researchers, academicians and technicians. They all have contributed to my understanding and valuable thoughts during my project.

First and foremost, I wish to express my sincere appreciation to both my supervisors, Dr. Mohd Rosli bin Hainin and my co-supervisor Dr. Haryati Yaacob for encouragement, guidance and critics. Their kindness and encouragement helped me to persevere along the way. Without their continued support and advices, this thesis would not have been the same.

Last but not least, I am grateful to all my family members for their moral and financial support and understanding all this time.

ABSTRACT

Road pavements like other civil infrastructures have a service life. Asphalt pavements get aged and become weaker. Bitumen plays a key role in aging of asphalt. In previous studies, bitumen aged separately and then it added to the asphalt mixture while in reality bitumen ages within asphalt mixture. In this study, asphalt mixture was aged to simulate the site condition. Two types of bitumen 60/70 and 80/100 were used in samples and tested for aging according to AASHTO R 30 for short-term and long-term, and then Samples were tested for resilient modulus, dynamic creep test and indirect tensile strength ratio. Aged samples were compared to the conventional ones (no aging) to indicate the effect of aging on asphalt mix. Results showed that resilient modulus for both types of bitumen were almost the same, especially at 40˚C temperature. Permanent deformation and tensile strength ratio of asphalt mixture decreased as it aged.

ABSTRAK

Turapan jalan mempunyai jangka hayat perkhidmatan, sama seperti infrastuktur kejuruteraan awam yang lain. Turapan berasfalt melalui proses penuaan dan menjadi lemah. Bitumen memainkan peranan yang penting dalam penuaan turapan berasfalt. Dalam kajian-kajian terdahulu, proses penuaan bitumen dilakukan berasingan sebelum dimasukkan ke dalam campuran berasfalt, walhal realitinya penuaan bitumen berlaku di dalam campuran berasfalt. Dalam kajian ini, proses penuaan sebenar disimulasikan dengan penuaan campuran berasfalt. Dua jenis bitumen gred 60/70 dan 80/100 PEN diguna dan diuji untuk penuaan jangka pendek dan jangka panjang berdasarkan AASHTO R 30. Kemudian, ujian *resilient modulus, dynamic creep* dan *indirect tensile strength ratio* dijalankan ke atas sampel tersebut. Keputusan ujian ke atas sampel yang melalui proses penuaan dibandingkan dengan sampel konvensional (tanpa penuaan) untuk mendapatkan kesan penuaan ke atas campuran berasfalt. Keputusan ujian menunjukkan kedua-dua gred bitumen menghasilkan nilai *resilient modulus* yang hampir sama, terutamanya pada suhu 40˚C. Nilai perpalohan dan *tensile strength ratio* menurun apabila berlaku penuaan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AASHO	-	American Association of State Highway Officials
AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society of Testing and Materials
FHW A	-	Federal Highway Administration
HMA	-	Hot mix asphalt
NAPA	-	National Asphalt Paving Association
OBC	-	Optimum bitumen content
PG	-	Performance Grade
RTFOT	-	Rolling thin film oven test
SHRP	-	Strategic Highway Research Program
TFOT	-	Thin film oven test
TMD	-	Theoretical maximum density
VFA	-	V oid Filled with Asphalt
VMA	-	V oid in Mineral Aggregate
VTM	-	Void Total in Mix

CHAPTER 1

INTRODUCTION

1.1 Overview

Road is the most popular option for the land transportation. A good an efficient road and highways network make land transportation easy and comfortable. An effective road network has lots of economical benefits for that country. Since the road pavement plays primary rule in smooth and convenience travel on road, it is essential to keep road condition as good as possible. There are two types of road pavement, flexible pavement (asphalt) and rigid pavement (concrete). There are many types of flexible pavement, for example asphaltic concrete, stone mastic asphalt, porous asphalt. The roads have specific design life based on traffic loading. For preventing accident by users damaged roads should be repaired which is so costly. Another solution for producing long lasting asphaltic pavement is modifying the asphalt mixture. The most important component in asphalt mixture for improving the asphalt life is bitumen.

1.2 Problem of Statement

After construction, pavement interface with rainfall, traffic load vehicles and other condition, which lead to many damages to the road. These damages can cause accident to road users. In addition after passing some years asphalt surface hasn't have its first performances. Rutting, loss of skid resistance, cracking and many other defects decreases the quality of pavement.

One way to prevent these problems is maintenance the road. Basically road construction and maintenance are considered costly to the government. As a matter of fact most countries consider the road and highways network as a valuable properties, which many investments have been implemented. Now importance of road and highways network is shown. It is so clear that many countries want to keep their transportation network in a reasonable condition to have the most possible utilization. There are two feasible method for achieving these purposes. First is keep maintaining the road which requires many times and man power, etc. Also maintaining is so costly. Another possible method is to make the design life of pavement longer. With a little attention to mixture design and proper construction road can be used for a longer period. After construction the pavement asphalt oxidized and get aged.

Making pavement design life longer requires reconsidering the asphalt mixture. Bitumen as one of the component in asphalt mixture has predominant role in aging of asphaltic pavement.

1.3 Objective of Study

Durable bitumen is required for the pavement to perform during its design life. Therefore, the bitumen must be resistant to change over time. Such development leads to failure due to hardening (embrittlement) and it is more severe in warmer climate. Bitumen is a important constituent of an asphalt mixture, the quality and properties of concrete depend largely on the chemical composition of the bitumen. The important requirements for bituminous pavements are resistance to permanent deformation and cracking induced by ageing.

The aim of this study is to understand the effect of ageing on the asphalt pavement and its performance. The study focuses on binder ageing which is considered as the main reason for durability in asphalt. Other intention of the study is to understand the effects of ageing on the rheological properties of the binder and the implications to rutting and cracking in asphalt pavement. The specificity of the research can be summarized in understanding ageing of binder, its effect on properties of asphalt and limitations of bitumen and asphalt ageing simulation.

1.4 Scope of Study

The scope of this study is testing the aggregate of AC14 and evaluating of aging on asphalt mixture

REFERENCES

Tashman, L., E. Masad, H. Zbib, D. Little, and K. Kaloush. Microstructural Viscoplastic Continuum Model for Asphalt Concrete. *Journal of Engineering Mechanics*, Vol. 131, No. 1, 2005, pp. 48–57

Feng Zhang□, Jianying Yu, Shaopeng Wu. "Effect of ageing on rheological properties of storage-stable SBS/sulfur-modified asphalts", Journal of Hazardous Materials 2006

Shaopeng Wu a,*, Ling Pang a, Lian-tong Mo a,b, Yong-chun Chen a, Guo-jun Zhu. "Influence of aging on the evolution of structure, morphology and rheology of base and SBS modified bitumen", Journal of Construction and Building Materials,

G.D. Airey "State of the Art Report on Ageing Test Methods for Bituminous Pavement Materials", a Nottingham Centre for Pavement Engineering, University of Nottingham, University Park, NGRD, 7 2, Nottingham, UK, 2007

Shaopeng Wu1; Ling Pang2; Gang Liu3; and Jiqing Zhu4, "Laboratory Study on Ultraviolet Radiation Aging of Bitumen" 772 / Journal Of Materials In Civil Engineering © Asce / August 2010

H.U. Bahia and D.A. Anderson, "Physical Hardening of Paving Grade Asphalts as Related to Compositional Characteristics", The Pennsylvania Transportation Institute Research OfficeBuilding University Park, PA 16802

C.A. Bell Alan J. Wieder Marco J. Fellin, "Laboratory Aging of Asphalt-Aggregate Mixtures" Field Validation. Oregon State University Corvallis, OR 97331, National Research Council, Washington, Program Council

The Asphalt Handbook, Asphalt Institute. Manual Series NO.4(MS-4), 1989 Edition.

Robert N Hunter, Asphalt in road Construction, Thomas Telford Publishing, Thomas London 2000

Tiong Hwa Nguong's Mater Project, Faculty of Civil Engineering, universiti Technologi Malaysia, June 2008.

Asphalt Institute (1990). “Introduction to Asphalt.” Lexington, Kentucky, United States of America: Asphalt Institute, Research Park Drive.

Chiu, C.T., Tia, M., Ruth, B.E., and Page, G.C. (1994). “Investigation of Laboratory Aging Processes of Asphalt Binders Used in Florida.” Transportation Research Record 1436 Materials and Construction. Washington, D.C.: Transportation Research Board.

Lu, X., and Isacsson, U. (2001). “Effect of ageing on bitumen chemistry and rheology.”
Construction and Building Materials. 16 (2002) 12-22

Zupanick, M. (1994). “Comparison of the thin film oven test and the rolling thin film oven test.” Journal of the Association of Asphalt Paving Technologists. 63: 346– 372.

“Standard Specification for Road Works”, JKR/SPS/2008-S4