SHORT-TERM AGEING EFFECTS ON ASPHALT BINDERS

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To my beloved mother and father
and dear family

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ABSTRACT

Asphalts undergo two substantially different ageing processes in their service life. They are subjected to high temperatures and a high degree of air exposure during their relatively short production time (short term ageing) and then to the environment at a relatively lower temperature and air void content for a long duration (long-term ageing). A variety of methods have been proposed and investigated to simulate the aging effects on asphalt during mixing as well as field service. Only short-term ageing was pursuit in this study, where the thin film oven test and rolling thin film oven test will be utilized to simulate the ageing. There is no direct measure for asphalt binder ageing. Rather, ageing effects are accounted for by subjecting asphalt samples to simulated ageing and conducting other standard physical tests (such as viscosity, penetration, and softening point) afterwards. The main purpose of this study was to compare the ageing effects from both ageing methods for three types of asphalt binders. From the t-test analysis, the two ageing methods result in almost similar rheological properties ($p > 0.05$).

ABSTRAK

Asfalt melalui dua proses penuaan penting yang berbeza sepanjang perkhidmatannya. Ia terdedah kepada suhu yang tinggi dan udara yang terlampau semasa pengaulan (penuaan jangka pendek) dan kemudiannya kepada alam sekitar pada suhu dan kandungan lompang yang lebih rendah secara relatifnya untuk jangka masa panjang (penuaan jangka panjang). Terdapat beberapa kaedah yang telah dicadangkan dan dikaji untuk menyimulasi kesan penuaan semasa proses pengaulan dan perkhidmatannya kepada asfalt. Hanya penuaan jangka pendek yang akan dijalankan dalam kajian ini, di mana kaedah oven filem nipis dan kaedah oven filem nipis berputar akan digunakan untuk menyimulasi proses penuaan. Setakat ini, masih tidak ada kaedah tertentu untuk menyukat langsung kesan penuaan asfalt. Sebaliknya, kesan penuaan asfalt akan diteliti dengan menjalankan ujian- ujian fizikal (contohnya ujian kelikatan, ujian penembusan dan ujian titik lembut) selepas penuaan. Objektif utama kajian ini adalah untuk membandingkan kesan penuaan dari dua kaedah penuaan untuk tiga jenis asfalt. Daripada analisis ujian-t, kedua- dua kaedah penuaan didapati menunjukkan kesan penuaan yang hampir sama ($p > 0.05$).

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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
FHWA	-	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
RV	-	Rotational viscometer
SHRP	-	Strategic Highway Research Program
TFOT	-	Thin film oven test
TMD	-	Theoretical maximum density
VFA	-	Void Filled with Asphalt
VMA	-	Void in Mineral Aggregate
VTM	-	Void Total in Mix

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CHAPTER I

INTRODUCTION

1.1 Research Background

Asphalts undergo two substantially different ageing processes in their service life. They are subjected to high temperatures and a high degree of air exposure during their relatively short production time (short term ageing) and then to the environment at a relatively lower temperature and air void content for a long duration (long-term ageing). A variety of methods have been proposed and investigated to simulate the aging effects on asphalt during mixing as well as field service. The purpose of this study was to conduct a laboratory evaluation of different short-term ageing processes' effects on asphalt binders commonly used in Malaysia.

There is no direct measure for asphalt binder ageing. Rather, ageing effects are accounted for by subjecting asphalt samples to simulated ageing and conducting other standard physical tests (such as viscosity, penetration, softening point, dynamic shear rheometer (DSR), bending beam rheometer (BBR) and the direct tension test (DTT)) afterwards (3.3 Materials – Asphalt, 2003). Simulating the effects of ageing is important because an asphalt binder in its virgin state may possess a different set of properties after ageing. Asphalt binder ageing is usually split up into two categories; short-term ageing which occurs when asphalt binder is mixed with hot aggregates in hot mix asphalt

(HMA) mixing facility; and long-term ageing which occurs after HMA pavement construction and is generally due to environmental exposure and loading.

1.2 Problem Statement

Asphalt binder ageing is one of the principal factors causing the deterioration of asphalt pavements (Lu and Isacsson, 2001). As it is, methods to repair and maintain the roads are costly with resurfacing, crack sealing, patching, thin HMA overlay, recycling, and reconstruction may well reach hundred of thousands at times. Thus, it is in the interest of the public to learn the characteristics of ageing asphalt binder so that an effective effort to maintain the roads conditions at the lowest cost can be carried out.

Fresh asphalt binders are tested for their rheological properties and then undergo ageing tests to simulate the short-term ageing. The aged asphalt binders are tested for their rheological properties again to evaluate the difference against the fresh material. Two ageing processes, namely thin film oven test and rolling thin film oven test are chosen to simulate the ageing environment. After-ageing tests on the asphalt binders from both methods are then compared to see the similarity of ageing effects between the two.

To date, there has been a limited research conducted to investigate rheological properties of ageing asphalt binders. Thus, there is a need to conduct an experiment to evaluate the effects of ageing (either short-term or long-term ageing) to asphalt binders. Only short-term ageing is pursuit in this study.

1.3 Aim of Study

The aim of this study is to conduct a laboratory evaluation of two ageing processes, namely thin film oven test (TFOT) and rolling thin film oven test (RTFOT) on asphalt binders commonly used in Malaysia. Both tests simulate the short-term ageing of the asphalt binder during the mixing and production in hot mix asphalt facility. Although the tests might not represent the same environment in which the asphalt binders go through during the production in hot mix asphalt facility for them to showcase the actual properties of the asphalt mixture, it is still a good and easy way to get a rough measure of ageing effects on asphalt binders. The ageing effects are observed in three tests, namely the penetration test, the viscosity test and the softening point test.

1.4 Objectives of Study

This study focuses on the following objectives to achieve the above aim.

1. To evaluate the effects of ageing on asphalt binders and to compare the rheological properties between the virgin and aged asphalt binders.
2. To compare the two different ageing methods, TFOT and RTFOT.

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