

# SHORT-TERM AGEING EFFECTS ON ASPHALT BINDERS

TIONG HWA NGUONG

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Universiti Teknologi Malaysia

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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 pursued 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 lumpur 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 ( $p > 0.05$ ).

## TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	<b>DECLARATION OF THE STATUS OF THESIS</b>	
	<b>SUPERVISOR’S DECLARATION</b>	
	<b>TITLE PAGE</b>	
	<b>DECLARATION</b>	ii
	<b>DEDICATION</b>	iii
	<b>ACKNOWLEDGEMENT</b>	iv
	<b>ABSTRACT</b>	v
	<b>ABSTRAK</b>	vi
	<b>TABLE OF CONTENTS</b>	vii
	<b>LIST OF TABLES</b>	xi
	<b>LIST OF FIGURES</b>	xiii
	<b>LIST OF ABBREVIATIONS</b>	xv
	<b>LIST OF APPENDICES</b>	xvi
<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
	1.1 Research Background	1
	1.2 Problem Statement	2
	1.3 Aim of Study	3
	1.4 Objectives of Study	3
	1.5 Significance of Study	4



3.5.2	Procedures	26
3.6	Consistency Tests	28
3.6.1	Penetration Test	28
3.6.1.1	Apparatus	30
3.6.1.2	Procedures	31
3.6.2	Softening Point Test	32
3.6.2.1	Apparatus	33
3.6.2.2	Procedures	33
3.6.3	Viscosity Test	35
3.6.3.1	Apparatus	36
3.6.3.2	Procedures	36
3.7	Marshall Mixture Design Method	38
3.7.1	Aggregate	38
3.7.2	Sieve Analysis for Fine and Coarse Aggregate	39
3.7.2.1	Apparatus	39
3.7.2.2	Procedures	39
3.7.3	Aggregate Gradation	40
3.7.4	Washed Sieve Analysis of Mineral Filler	42
3.7.4.1	Apparatus	42
3.7.4.2	Procedures	43
3.7.5	Asphalt Binder Content	43
3.7.6	Theoretical Maximum Density (Loose Mix)	44
3.7.6.1	Apparatus	45
3.7.6.2	Procedures	46
3.7.7	Marshall Sample Preparation	47
3.7.7.1	Apparatus	47
3.7.7.2	Procedures	48
3.7.8	Flow and Stability Test	51
3.7.8.1	Apparatus	53
3.7.8.2	Procedures	54
3.8	Data Analysis	57



3.8.1	Bulk Specific Gravity	57
3.8.2	Void in Mineral Aggregate (VMA)	58
3.8.3	Void in Total Mix (VTM)	58
3.8.4	Void Filled with Asphalt (VFA)	59
3.8.5	Determination of Optimum Bitumen Content	60
3.8.6	T-test	60
<b>4</b>	<b>RESULTS AND DATA ANALYSIS</b>	<b>62</b>
4.1	Introduction	62
4.2	Data Analysis	62
4.3	Penetration Test Results	63
4.4	Softening Point Test Results	64
4.5	Viscosity Test Results	65
4.5.1	PEN 80-100	65
4.5.2	PG70	66
4.5.3	PG76	67
4.6	Theoretical Maximum Density	68
4.7	Optimum Asphalt Content	69
4.8	T-test Analysis	70
<b>5</b>	<b>CONCLUSIONS</b>	<b>72</b>
5.1	Introduction	72
5.2	Conclusion	72
	<b>REFERENCES</b>	<b>75</b>
	<b>APPENDICES A-G</b>	<b>77</b>

## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Comparison of TFOT and RTFOT methods	14
3.1	Values of penetration and the maximum discrepancy allowed	32
3.2	Total number of ACW14 samples	38
3.3	Gradation Limits for Asphaltic Concrete	41
3.4	Gradation Used for ACW14 Marshall	42
3.5	Asphalt binder content design	43
3.6	Gradation Used for ACW14 TMD	45
4.1	Fresh and TFOT aged asphalt binders penetration test results	63
4.2	Fresh and RTFOT aged asphalt binders penetration test results	63
4.3	Fresh, TFOT and RTFOT aged asphalt binders softening point test results	64
4.4	PEN 80-100 samples' viscosity at respective temperatures	65
4.5	PG70 samples' viscosity at respective temperatures	66
4.6	PG76 samples' viscosity at respective temperatures	67
4.7	TMD at each increment of asphalt content for PEN 80-100	68
4.8	TMD at each increment of asphalt content for PG70	68
4.9	TMD at each increment of asphalt content for PG76	69
4.10	Breakdown of parameters of ACW14 in favour of 75	70

	blows	
4.11	T-test for PEN 80-100 between TFOT and RTFOT	71
4.12	T-test for PG70 between TFOT and RTFOT	71
4.13	T-test for PG76 between TFOT and RTFOT	71

**LIST OF FIGURES**

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
3.1	The operational framework for the tests and analysis	22
3.2	Flow chart of experimental design procedure for evaluating the ageing difference between TFOT and RTFOT	23
3.3	Thin film oven	25
3.4	Weighing the asphalt binder	25
3.5	Rotating shelf in the oven	25
3.6	Rolling thin film oven	27
3.7	The inside of rolling thin film oven	27
3.8	Preparing the asphalt binder samples for ageing	28
3.9	Penetration test for an asphalt binder sample	29
3.10	Water bath	29
3.11	Ring and Ball apparatus	34
3.12	Thermosel and Viscometer	37
3.13	Sieved aggregates in their respective containers according to size	40
3.14	Vacuum pump and vacuum container	46
3.15	Heating samples prior to Marshall design mix	49
3.16	Mixing the aggregates with the asphalt	50
3.17	Compaction hammer	50
3.18	Flow determination for two types of specimen failure	52

3.19	Flow and stability test	55
3.20	Compression loading machine and load measuring device	56
3.21	Water bath	56

**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

**LIST OF APPENDICES**

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
A	Hydrographs for year 2006 from February to December	77
B	Marshall test result spread sheet for PEN 80-100	78
C	Marshall graphs of ACW14 for PEN 80-100	79
D	Marshall test result spread sheet for PG70	80
E	Marshall graphs of ACW14 for PG70	81
F	Marshall test result spread sheet for PG76	82
G	Marshall graphs of ACW14 for PG76	83

## **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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