

TABLE OF CONTENTS

CERTIFICATE -----	i
DECLARATION BY THE CANDIDATE -----	ii
COPYRIGHT TRANSFER CERTIFICATE -----	iii
DEDICATION -----	iv
ACKNOWLEDGEMENT -----	v
TABLE OF CONTENTS-----	x
LIST OF FIGURES-----	xvi
LIST OF TABLES -----	xxii
ABSTRACT -----	xxiv
Chapter 1 INTRODUCTION -----	1
1.1 Prologue -----	1
1.2 Fatigue Cracking in Asphalt Pavements -----	1
1.3 Role of Filler -----	3
1.4 Importance of Asphalt Mastic -----	4
1.5 Fatigue Testing -----	5
1.6 Research Gaps -----	5
1.7 Goals and Objectives -----	7
1.8 Organization of the Thesis -----	8
Chapter 2 LITERATURE REVIEW -----	12

2.1	Prologue -----	12
2.2	Asphalt mastic -----	12
2.2.1	Mineral filler -----	13
2.2.2	Asphalt Binder -----	14
2.2.3	Filler-Binder (F-B) ratio -----	17
2.3	Rheological Characterization of Asphalt Materials -----	18
2.3.1	Viscoelasticity-----	18
2.3.2	Aging -----	19
2.3.3	Dynamic Mechanical Analysis (DMA) -----	20
2.3.4	Time Temperature Superposition Principle (TTSP)-----	22
2.4	Fatigue Cracking -----	23
2.4.1	Mechanism of Cracking -----	24
2.4.2	Mode of Loading -----	25
2.4.3	Fatigue in Mixes -----	25
2.4.4	Fatigue Testing of Binders or Mastics-----	34
2.4.5	Testing Geometry-----	48
2.5	Problem Statement -----	57
Chapter 3 RESEARCH METHODOLOGY	-----	58
3.1	Prologue -----	58
3.2	Phase I: Material Collection and Characterization -----	58
3.3	Phase II: Fabrication of Asphalt Mastics, Aging, and Evaluation of LVE Limits ---	59

3.4	Phase III: Selection of Alternate Fatigue Test and Appropriate Testing Geometry	-62
3.5	Phase IV: Fatigue Analysis of Asphalt Binders and Asphalt Mastics -----	66
3.6	Phase V: Fatigue Performance Evaluation of the Asphalt Mixtures-----	66
Chapter 4	FILLER CHARACTERIZATION AND DESIGN OF ASPHALT MASTICS -----	70
4.1	Prologue -----	70
4.2	Fillers -----	70
4.2.1	Red mud-----	72
4.2.2	Quartz -----	73
4.2.3	Marble dust -----	74
4.2.4	Limestone-----	74
4.2.5	Granite-----	74
4.2.6	Basalt -----	75
4.3	Characterization of Fillers -----	75
4.3.1	Particle Size Analysis (PSA)-----	76
4.3.2	Rigden Voids -----	78
4.3.3	Methylene Blue Value (MBV)-----	80
4.3.4	X-Ray Diffraction (XRD) Analysis-----	82
4.3.5	Scanning Electron microscope (SEM) Image Analysis -----	87
4.3.6	Specific Surface Area (SSA)-----	90
4.3.7	Specific Gravity-----	92
4.3.8	Filler Grain Coefficient (FGC) -----	93

4.4	Correlation Analysis -----	93
4.5	Asphalt Binder-----	95
4.6	Preparation of Asphalt Mastics-----	96
4.7	Aging-----	96
4.8	Comparison with SHRP LVE limits-----	97
4.9	Summary -----	100
Chapter 5 ALTERNATE FATIGUE TEST AND TESTING GEOMETRY-----		102
5.1	Prologue -----	102
5.2	Correction Factors-----	104
5.2.1	Correction Factor for Shear Stress -----	104
5.2.2	Correction Factor for Shear Strain -----	105
5.2.3	Correction Factor for Complex Modulus-----	105
5.3	Fabrication of Hyperbolic Geometry Mold-----	106
5.4	Hyperbolic Geometry Fabrication -----	108
5.5	Suitability of LAS Test as an Alternative to TS Test -----	109
5.5.1	Correlation Analysis-----	110
5.5.2	Ranking Analysis -----	116
5.5.3	Discrepancy Analysis -----	117
5.6	Efficacy of Hyperbolic Geometry as a Better Alternative to Cylindrical Geometry	
	123	
5.7	Summary -----	134

Chapter 6 FACTORS AFFECTING THE FATIGUE BEHAVIOR OF ASPHALT MASTICS-----	135
6.1 Prologue -----	135
6.2 Effect of Applied Strain -----	136
6.2.1 Discrepancy Analysis -----	139
6.3 Effect of Temperature -----	142
6.4 Effect of Filler Type -----	148
6.5 Effect of Filler-Binder Ratio-----	156
6.6 Effect of Binder-----	163
6.7 Glover-Rowe (GR) Parameter-----	165
6.8 Summary -----	169
Chapter 7 PERFORMANCE EVALUATION OF ASPHALT MIXTURES-----	170
7.1 Prologue -----	170
7.2 Preparation of Asphalt Mixtures -----	170
7.2.1 Aggregates -----	170
7.2.2 Gradation of Aggregates-----	171
7.2.3 Batching-----	172
7.2.4 Mixing-----	173
7.2.5 Conditioning-----	173
7.2.6 Compaction-----	174
7.2.7 Mix Design Parameters -----	176
7.2.8 Determination of Number of Blows to Achieve Target Air Void Content----	179

7.2.9	Long Term Aging of the Samples -----	179
7.3	Performance Analysis via SCB Testing-----	180
7.4	Optimum Binder Content (OBC) -----	189
7.5	Determination of Optimum Filler Dosage-----	194
7.6	Summary -----	201
Chapter 8 CONCLUSIONS AND FUTURE SCOPE-----		203
8.1	Prologue -----	203
8.2	Conclusions -----	204
8.2.1	Filler Characterization -----	204
8.2.2	Selection of Alternate Fatigue Test -----	205
8.2.3	Assessment of Better Testing Geometry -----	206
8.2.4	Fatigue Analysis of Asphalt Mastics and Asphalt Binder -----	207
8.2.5	Performance Evaluation of Asphalt Mixtures -----	208
8.3	Summary -----	210
8.4	Future Scope -----	210
8.5	Research Contribution-----	211
8.6	Practical Applications of the Study -----	213
REFERENCES-----		214
LIST OF PUBLICATIONS-----		259