

DECLARATION

" I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any University to the best of my knowledge and belief it does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organizations"

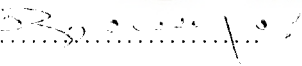

.....

Signature of the Candidate

22 08 2008
.....

Date

To the best of my knowledge, the above particulars are correct.


.....

Supervisor



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Dr. M. A. W. Kumara, for his excellent guidance and assistance extended throughout the research programme. Dr. Kumara has been supportive as a supervisor and has given me encouragement and inspiration during the research programme. His devotion in the subject of Asphalt Concrete is also acknowledged.

My gratitude is extended to Dr. (Mrs.) H. L. D. M. A. Judith, for their valuable insights and suggestions received during progress reviews and in some specific areas.

My special thanks to the University of Moratuwa for the services provided during the research programme. And also many thanks to the Road Development Authority for granting me leave to following this course.

The assistance received from staff of Bitumen laboratory, Research and Development Division, Road Development Authority, during the laboratory testing programme is acknowledged.



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

25th July 2008

CONTENTS

DECLARATION	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
CHAPTER 1 INTRODUCTION.....	1
1.1 General.....	1
1.2 Problem Statement.....	3
1.3 Objectives of Study.....	4
1.4 Research Approach, Scope and Limitations.....	5
1.5 Organization of Report	6
CHAPTER 2 LITERATURE REVIEW.....	7
2.1 Aggregate Characteristics.....	7
2.2 Aggregate Gradation.....	8
2.3 Fine Aggregates	9
2.4 Coarse Aggregate.....	10
2.5 Filler.....	11
2.6 Restricted zone.....	12
2.7 Mix Design Methods	13
2.7.1 Marshall Method.....	14
2.7.2 Hveem Method	15
2.7.3 Superpave Method	15
2.8 Superpave Specifies Aggregate Gradation	16
2.9 Aggregate Gradation Specifications for Wearing Course	16
2.9.1 ASTM D 3515 Specification	17
2.9.2 SSCM (1989) Specification	17
2.9.3 CSRA (1987) Specification	17
2.9.4 Kentucky Department of Highways	18
2.10 Voids in the Mineral Aggregate (VMA)	18
2.11 Marshall Flow	18
2.12 Marshall Stability.....	19
2.13 Mixture Air Voids.....	19
2.14 Binder Film Thickness.....	19
2.15 Aggregate Blending.....	20
2.16 Specific Gravity of Aggregate	21
2.17 Expected Design Binder Content.....	21
CHAPTER 3 METHODOLOGY OF STUDY.....	22
3.1 Plan of Study	22
3.2 Material Acceptance and Evaluation	22
3.3 Preparation of specimen	24
3.4 Specimen Compaction	25
3.5 Density – Void Analysis.....	25
3.5.1 Bulk specific gravity of aggregate.....	25

3.5.2 Apparent specific gravity of aggregate.....	25
3.5.3 Effective specific gravity of aggregate.....	26
3.5.4 Bulk specific gravity of compacted specimen.....	26
3.5.5 Maximum specific gravity.....	26
3.5.6 Bitumen absorption of the aggregate.....	26
3.5.7 Effective bitumen content of mixture.....	27
3.5.8 Percent of void in the mineral aggregate (VMA).....	27
3.5.9 Percent of air voids in the compacted mixture (Va).....	27
3.6 Marshall Stability and Flow	27
3.7 Optimum Binder Content Determination	28
CHAPTER 4 OBSERVATIONS AND RESULTS	32
4.1 Marshall Mix Properties and Binder Tolerance.....	32
4.2 Film Thickness of mixtures	33
CHAPTER 5 ANALYSIS AND DISCUSSION OF RESULTS.....	35
5.1 Introduction.....	35
5.2 General Observations and Preliminary Data Analysis	35
5.3 Data Analysis.....	35
5.4 Comparison of Marshall Parameters	36
5.4.1 Marshall Stability.....	36
5.4.2 Marshall Flow	36
5.4.3 Void in Mineral Aggregate.....	37
5.4.4. Air Voids (V_a).....	38
5.5 Comparison of some other parameters	38
5.5.1 Optimum Binder Content	38
5.5.2 Binder Tolerance	39
5.5.3 Average Film Thickness.....	40
CHAPTER 6 CONCLUSIONS AND RECOMENDATIONS.....	42
6.1 Introduction.....	42
6.2 Conclusions	42
6.3 Recommendations.....	42
REFERENCES	43
APPENDIX A MIX DESIGN GRADATION	46
APPENDIX B MARSHALL MIX PROPERTIES	48
APPENDIX C SURFACE AREA & FILM THICKNESSES	77
APPENDIX D SAMPLE CALCULATION	79
APPENDIX E AGGREGATE BLENDING.....	81

LIST OF FIGURES

Figure 1.1 Superpave Specifies Gradation for 19.0 mm nominal size	3
Figure 1.2 Superpave & SSCM aggregate specifications (Log scale).....	4
Figure 1.3 Superpave & SSCM aggregate specifications (0.45 power chart).	4
Figure 3.1 Gradations above the restricted zone	29
Figure 3.2 Gradations through the restricted zone.....	30
Figure 3.3 Gradations below the restricted zone	31
Figure 5.1 Optimum Binder Content	39
Figure 5.2 Binder Tolerances with Types of Gradation	39
Figure 5.3 Average Film Thicknesses with Types of Gradation	40
Figure 5.4 Surface Area vs Average Film Thickness	41

LIST OF TABLES

Table 2.1 Superpave Asphalt Mixture Gradation Requirements.....	16
Table 2.2 ASTM D 3515 gradation for wearing course (19 mm nominal size).....	17
Table 2.3 SSCM gradation for wearing course (19 mm nominal size)	17
Table 2.4 CSRA gradation for surfacing mixture.....	17
Table 3.1 Acceptance test for Asphalt Binder	23
Table 3.2 Acceptance test for Mineral Aggregate	24
Table 3.3 SSCM Marshall Design Criteria & Limits	28
Table 4.1 Test Value of Mixes above the restricted zone.....	32
Table 4.2 Test Value of Mixes through the restricted zone.....	32
Table 4.3 Test Value of Mixes below the restricted zone	33
Table 4.4 Film Thickness Value of Mixes above the restricted zone.....	33
Table 4.5 Film Thickness Value of Mixes through the restricted zone.....	34
Table 4.6 Film Thickness Value of Mixes below the restricted zone	34
Table 5.1 Comparison of Marshall Stability.....	36
Table 5.2 Comparison of the Marshall Flow.	37
Table 5.3 Comparison of the VMA of different aggregate gradations.....	37
Table 5.4 Comparison of the Va.....	38