ESTIMATION OF PENETRATION REQUIREMENTS FOR PRIME COAT

KASTHURI ARACHCHIGE NEMINDA SENARATH KASTHURIRATHNA

(138312B)

Degree of Master of Engineering

Department of Civil Engineering

University of Moratuwa
Sri Lanka

February, 2018

ESTIMATION OF PENETRATION REQUIREMENTS FOR PRIME COAT

KASTHURI ARACHCHIGE NEMINDA SENARATH KASTHURIRATHNA

(138312B)

Thesis submitted in partial fulfilment of the requirements for the degree Master of Engineering

Department of Civil Engineering

University of Moratuwa
Sri Lanka

February, 2018

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Master's thesis under my supervision.

Signature of the supervisor: Date:

ABSTRACT

Prime coat application is a necessary activity in road constructions. The main function of the prime coat is to seal capillary voids in the base course surface to prevent migration of moisture to the base course and underneath layers. However it is not carried out up to the required standards. The prime penetration into the road base is the most important consideration. In the local context, the application of prime coat has been a common practice in road construction projects though there is no specification for penetration requirements. This is an issue of concern as there should be a basis for selecting the best type of prime coat in terms of the penetration and penetration requirement for respective type of processed bitumen as well. Commonly used types of processed bitumen for prime application in Sri Lanka are MC-30 (Medium Curing cut back bitumen) and CSS-1 (Cationic Slow Setting). The experimental research was done using both types of bitumen and the Aggregate Base Course (ABC) specified in the Standard Specifications for Construction and Maintenance of Roads and Bridges [2nd Edition – June 2009] specification as the road base. Specimens were casted in AASHTO specified CBR moulds at selected degree of compaction and was sprayed at selected rates under typical defined Sri Lankan conditions. Penetration requirement and required curing time were selected for each degree of compaction and rate of application, and then the penetration requirements for respective required curing time were plotted against the base compaction and rate of application. There is no significant difference of required penetration for both type of bitumen but MC-30 has shown a relatively higher penetration for few time intervals to make it arguably the best to select in terms of the penetration into the base among the two types of bitumen tested. The penetration requirements for MC-30 and CSS-1 with the time are presented and can be used to make decisions on the best type of bitumen to use in terms of penetration and required penetration for a selected type of bitumen with curing time.

DEDICATION

This thesis is dedicated

To

My wife and parents for their support and encouragement

ACKNOWLEDGEMENT

I would like to acknowledge many people who supported me to complete the master's research successfully. First of all I would like to thank my project supervisor Dr. H.R. Pasindu who instructed and guided me to make this a success and gave me the opportunity to explore many areas through guidance and his helpful information to complete the research.

This research would not have been possible if it wasn't for the lecturer's comments and guidance from academic and professional experts in respective fields. Therefore I would like to thank the Master of Engineering lecture panel including Dr. H.R. Pasindu, Dr. W.K. Mampearachchi, Prof. J.M.S.J. Bandara, Mr. Loshaka Perera and other all the lecturers for their valuable lectures, comments and guidance.

Thank goes to Prof. (Mrs.) Chintha Jayasinghe, Director Post Graduate Studies and Prof. S.M.A. Nanayakkara, Head of the Department of Civil Engineering for facilitating the official process.

In addition, I would like to thank the staff of Research and Development division of Provincial Road Development Authority who helped to conduct laboratory testing.

Further I would like to thank the staff of Transportation Engineering division of department of Civil Engineering of University of Moratuwa for their continuous support.

Thank goes to Oru Mix Asphalt (Pvt) Ltd and Bitumix (Pvt) Ltd for providing materials and Research and Development division of Road Development Authority (RDA) for testing bitumen.

Last but not least I would like to thank my parents for their unending support throughout my journey. Without them I wouldn't be able to accomplish any of the achievements that I have attained so far.

Kasthuri Arachchige Neminda Senarath Kasthurirathna
138312B
Transportation Engineering Division
Department of Civil Engineering
University of Moratuwa

TABLE OF CONTENTS

Page

DECLARATION i

ABSTRACT ii

DEDICATION iii

ACKNOWLEDGEMENT iv

TABLE OF CONTENTS v

LIST OF FIGURES vii

LIST OF TABLES viii

LIST OF ABBREVIATIONS ix

1. INTRODUCTION 1

1.1 Problem Statement and Background 1

1.2 Objectives of the Study 1

1.3 Scope of Work 1

2. LITERATURE REVIEW 3

2.1 Pavement Structure 3

2.2 Introduction to prime coat 3

2.3 Introduction to Aggregate Base Course (ABC) 4

2.4 Uses of prime coat 5

2.5 Important factors related to prime coat 5

3. METHODOLOGY 7

3.1 MATERIAL SELECTION 7

3.1.1 MC -30 7

3.1.2 CSS-1 8

3.1.3 Aggregate Base Course (ABC) 8

3.2 Casting ABC specimens 12

3.2.1 Proctor compaction test 12

3.2.2 Selecting number of blows required to achieve compaction (Trial) 14

3.2.3 Application of prime....16

4. RESULTS AND DISCUSSION.... 19

4.1 Penetration results for MC -30....19

4.2 Penetration results for CSS -1....21

4.3 Comparison of results....23

4.4 Selection of application rate....25

5. CONCLUSION AND RECOMMENDATIONS 27

REFERENCES 28

Appendix I - CD

LIST OF FIGURES

Page

Figure 1: A Typical Pavement Structure for flexible pavement 3
Figure 2: Reduction of sample 10
Figure 3: Mechanical Sieve shaker 10
Figure 4: Sieves 10
Figure 5: Aggregate for AIV test 10
Figure 6: Performing AIV test 11
Figure 7: Performing FI test 11
Figure 8: CBR Vs Degree of Compaction relationship 11
Figure 9: Proctor Compaction graph 13
Figure 10: Weighing sample 13
Figure 11: Casting ABC specimen 13
Figure 12: Prepared material, apparatus and casted specimen 14
Figure 13: Degree of Compaction achieved in trial 15
Figure 14: A cross section I 18
Figure 15: A cross section II 18
Figure 16: A cross section III 18
Figure 17: A cross section IV 18
Figure 18: Neglected areas for measurements 18
Figure 19: Penetration requirement at common curing time MC -30 21
Figure 20: Penetration requirement at common curing time CSS -1 23
Figure 21: Comparison of 0.5 l/m^2 application rate penetration results 23
Figure 22: Comparison of 1.0 l/m^2 application rate penetration results 24
Figure 23: Comparison of 1.5 l/m^2 application rate penetration results 24
Figure 24: Lowest penetrations for MC -30 against application rate 25
Figure 25: Lowest penetrations obtained for CSS -1 against application rate 26

LIST OF TABLES

Page

Table 1: MC -30 Test results 7
Table 2: CSS -1 test results 8
Table 3: ABC Test results 9
Table 4: Sieve Analysis Test results 9
Table 5: AIV Test results 10
Table 6: California Bearing Ratio test results - Test method AASHTO - 193 11
Table 7: Proctor Compaction test results 12
Table 8: Degree of compaction achieved in trial 15
Table 9: Number of blows required to achieve compaction 16
Table 10: MC -30 Penetration readings for applying rate 0.5 l/m^2 19
Table 11: MC -30 Penetration readings for applying rate 1.0 l/m^2 19
Table 12: MC -30 Penetration readings for applying rate 1.5 l/m^2 19
Table 13: Maximum penetration of MC -30 and required curing time 20
Table 14: CSS -1 Penetration readings for applying rate 0.5 l/m^2 21
Table 15: CSS -1 Penetration readings for applying rate 1.0 l/m^2 21
Table 16: CSS -1 Penetration readings for applying rate 1.5 l/m^2 22
Table 17: Maximum penetration of CSS -1 and required curing time 22
Table 18: Lowest penetration of MC 30 against application rate 25
Table 19: Lowest penetration of CSS-1 against application rate 26

LIST OF ABBREVIATIONS

Abbreviation	Description
AASHTO	American Association of State Highway and Transportation Officials
ABC	Aggregate Base Course
AEP	Asphalt Emulsion Prime
AIV	Aggregate Impact Value
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
CIDA	Construction Industry Development Authority
CSS	Cationic Slow Setting
EPA	Environmental Protection Agency
HMA	Hot Mix Asphalt
ICTAD	The Institution of Construction Training & Development
IMC	Initial Moisture Content
MC	Medium Curing
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
RDA	Road Development Authority
SS	Slow Setting
VOC	Volatile Organic Compound