

TABLE OF CONTENTS

	Page
ABSTRACT (THAI)	I
ABSTRACT (ENGLISH)	III
ACKNOWLEDGMENT	V
TABLE OF CONTENTS	VI
LIST OF TABLES	IX
LIST OF FIGURES	X
SYMBOLS AND ABBREVIATIONS	XII
CHAPTER	
I INTRODUCTION.....	1
1.1 Statement of the problem.....	1
1.2 Objectives of the study.....	4
1.3 Organization of the dissertation	4
1.4 Reference	5
II LITERATURE REVIEW.....	7
2.1 Introduction	7
2.2 Specification for Pavement Construction.....	7
2.3 Recycled concrete aggregate (RCA) in construction.....	9
2.4 The Highway Construction.....	11
2.5 Recycled and reclaimed material in highway construction	13
2.6 Geopolymer stabilization material for highway construction	14
2.7 Recycle concrete aggregate (RCA).....	17
2.8 Bottom ash (BA)	18
2.9 Natural rubber latex (NRL).....	22
2.10 Reference	25
III METHODOLOGY STRENGTH DEVELOPMENT OF BOTTOM ASH GEOPOLYMER STABILIZED RECYCLED CONCRETE AS A ROAD CONSTRUCTION MATERIAL.....	33
3.1 Introduction	33
3.2 Materials and Methods.....	35

TABLE OF CONTENTS (Continued)

	Page
3.2.1 Materials	35
3.2.2 Mix Design and Sample Preparation	39
3.3 Laboratory Experimental Program	41
3.3.1 Unconfined Compressive Strength (UCS).....	41
3.3.2 Scanning Electron Microscopy (SEM) Analysis	41
3.3.3 X-Ray Diffraction (XRD) Analysis.....	42
3.4 Results and Discussion	42
3.4.1 UCS Development.....	42
3.4.2 Microstructural Analysis.....	47
3.4.3 EDX Analysis.....	50
3.4.4 XRD Analysis.....	54
3.5 Conclusions	57
3.6 References	58
IV PERFORMANCE OF NATURAL RUBBER LATEX MODIFIED BOTTOM ASH- BASED GEOPOLYMER STABILIZED RECYCLED CONCRETE AGGREGATE AS A PAVEMENT SUBBASE MATERIAL.....	64
4.1 Introduction	64
4.2 Materials and Method	66
4.2.1 Recycle Concrete Aggregate (RCA)	66
4.2.2 Bottom ash (BA).....	67
4.2.3 Natural rubber latex (NRL).....	70
4.2.4 Alkaline activator	70
4.2.5 Mix design and sample preparation.....	71
4.3 Mix design and sample preparation	72
4.3.1 Laboratory Experimental Program.....	73
4.3.2 Modified compaction test.....	73
4.3.3 Unconfined compressive strength	73
4.3.4 Scanning Electron Microscopy (SEM) analysis.....	74
4.3.5 X-Ray Diffraction (XRD) analysis	74
4.4 Results and Discussion	74
4.4.1 Unconfined compressive strength development	74

TABLE OF CONTENTS (Continued)

	Page
4.4.2 Microstructural Analysis.....	77
4.4.3 Effect of G/N ratio on microstructural property.....	77
4.4.4 Effect of NRL on microstructural property	80
4.4.5 XRD analysis.....	82
4.5 Conclusions	86
4.6 References	87
V CONCLUSIONS AND RECOMMENDATIONS.....	91
5.1 Summarization	91
5.2 Recommendation for future work	93
APPENDIX	
A PUBLICATIONS	94
BIOGRAPHY	128

LIST OF TABLES

Table		Page
2.1	Chemical composition and physical properties of coal ash.....	15
2.2	Basic engineering properties of Bottom ash.....	20
3.1	The mix design of the BA-based geopolymer-stabilized RCA in this study	40
4.1	Chemical compositions of bottom ash	67
4.2	The mix design of NRL-modified BA-based geopolymer stabilized RCA.....	77
4.3	EDX analysis of NRL-modified BA-based geopolymer stabilized RCA mixtures.....	79

LIST OF FIGURES

Figure	Page
2.1	Typical pavement construction layers9
2.2	XRD patterns of fly ash and bottom ash 15
2.3	Compressive strength of geopolymer mortars between FA and BA..... 17
2.4	SEM image of BA 20
2.5	Particle size distribution of original BA aggregate 21
2.6	Bottom ash waste from Mae Moh Electric power plant (EGAT) 21
2.7	Natural rubber latex (NRL) 23
3.1	Graduation of RCA and BA 36
3.2	XRD patterns of (a) RCA and (b) BA..... 37
3.3	SEM images of (a) RCA and (b) BA 37
3.4	Chemical compositions RCA and BA obtained from EDX..... 38
3.5	UCS of BA-based geopolymer-stabilized RCA samples at 7 and 28 days of ambient curing..... 43
3.6	Toughness of BA-based geopolymer-stabilized RCA samples..... 46
3.7	SEM images of RCA90BA10: (a) G/N ratio of 1:1, (b) G/N ratio of 1:1.5, and (c) G/N ratio of 1:2 at 28 days of curing 48
3.8	SEM images of RCA60BA40: (a) G/N ratio of 1:1, (b) G/N ratio of 1:1.5, and (c) G/N ratio of 1:2 at 28 days of curing 49
3.9	Chemical compositions of RCA90BA10 formulations at various G/N ratio..... 51
3.10	Chemical compositions of RCA60BA40 formulations at various G/N ratio..... 52
3.11	Si/Al ratios of RCA90BA10 and RCA60BA40 with various G/N ratios 53
3.12	XRD patterns of RCA90BA10 and RCA60BA40 with various G/N ratios..... 55
4.1	Grain size distribution of RCA and Bottom ash..... 68
4.2	Fresh Bottom ash at Mea Moh power plant, Thailand 69
4.3	SEM of as-received bottom ash and ground bottom ash (a) As-received bottom ash and (b) ground bottom ash 69
4.4	XRD pattern of bottom ash 70
4.5	UCS of NRL-modified BA-based geopolymer stabilized RCA samples..... 75

LIST OF FIGURES (Continued)

Figure	Page
4.6 SEM-EDX analysis of NRL-modified BA-based geopolymer stabilized RCA samples: a) RCA70BA30 (Control), b) G/N1:1.0NRL0.1, c) G/N1:1.5NRL0.1, and d) G/N1:2.0NRL0.1	78
4.7 SEM images of NRL-modified BA-based geopolymer stabilized RCA samples: G/N1:1.0NRL0.1, b) G/N1:1.0NRL0.2, and c) G/N1:1.0NRL0.3	81
4.8 XRD patterns of RCA70BA30 (Control sample)	83
4.9 XRD patterns of NRL-modified BA-based geopolymer stabilized RCA samples.....	84
4.10 XRD patterns of NRL-modified BA-based geopolymer stabilized RCA samples: a) G/N1:1.0NRL0.1, b) G/N1:1.0NRL0.2, c) G/N1:1.0NRL0.3.....	85

SYMBOLS AND ABBREVIATIONS

RCA	=	Recycled Concrete Aggregate
BA	=	Bottom ash
NaOH	=	Sodium Hydroxide
Na_2SiO_3	=	Sodium silicate
Na_2O	=	Sodium oxide
SiO_2	=	Silicon dioxide
UCS	=	Unconfined Compression Strength
SEM	=	Scanning Electron Microscopy
EDS	=	Energy Dispersive X-Ray Spectroscopy
XRD	=	X-ray Diffraction
G/N	=	(Sodium silicate/ Sodium Hydroxide) ratio
OLC	=	Optimum liquid content
OMC	=	Optimum moisture content
RT	=	Room temperature