

CONTENTS

CHAPTER	TITLE	PAGE
	ABSTRACT	i
	ACKNOWLEDGEMENT	ii
	CONTENT	iii
	LIST OF TABLES	v
	LIST OF FIGURES	ix
	NOMENCLATURES	xii
1	INTRODUCTION	1
	1.1 Rationale/Problem Statement	1
	1.2 Literature Review	2
	1.3 Research Objectives	6
	1.4 Scope of the Research	6
2	THEORIES	8
	2.1 Portland Cement	8
	2.2 Lightweight Concrete	20
	2.3 Aluminium	26
	2.4 Rice Husk Ash	29
	2.5 Phases Transformation in CaO-SiO ₂ -H ₂ O System	32
3	METHODOLOGY	35
	3.1 Materials	35
	3.2 Experimental Procedures	38
	3.3 Sample Preparation	38
	3.4 Microstructure Analysis	41
	3.5 Physical and Mechanical Analysis	43
4	THE EFFECTS OF ALUMINIUM POWDER ON STRENGTH AND DENSITY OF AERATED CONCRETE WITHOUT AUTOCLAVED CURING	45
	4.1 Introduction	45
	4.2 Research Objective	45
	4.3 Methodology	46
	4.4 Results and Discussion	46

CONTENTS (Cont')

CHAPTER	TITLE	PAGE
	4.5 Conclusion	48
5	THE EFFECTS OF AUTOCLAVING TIMES AND TEMPERATURES ON PROPERTIES OF AAC INCORPORATING RHA	50
	5.1 Introduction	50
	5.2 Materials	51
	5.3 Experimental	51
	5.4 Results and Discussion	52
	5.5 Conclusion	79
6	THE EFFECTS OF AI-CONTAINING WASTE FINENESS ON PROPERTIES OF AUTOCLAVE AERATED CONCRETE INCORPORATING RHA	81
	6.1 Introduction	81
	6.2 Materials	81
	6.3 Experimental	83
	6.4 Results and Discussion	84
	6.5 Conclusion	91
7	CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK	93
	7.1 Summary	93
	7.2 Recommendations	95
	REFERENCES	96
	APPENDIXES	
	APPENDIX A COMPRESSIVE STRENGTH RESULTS	106
	APPENDIX B DRY DENSITY RESULTS	116
	APPENDIX C THERMAL CONDUCTIVITY RESULTS	123
	APPENDIX D FLOW TABLE TESTING	124
	APPENDIX E STANDARD	125

LIST OF TABLES

Table	TITLE	PAGE
2.1	Oxide composition of ordinary Portland cement	11
2.2	Main compounds of Portland cement	13
2.3	The behaviour of main compounds which occur in Portland cement	13
2.4	The compound composition of Portland cement	15
2.5	Typical properties of NFC made with normal weight and lightweight aggregates	21
2.6	Classification of lightweight aggregate concrete	22
2.7	Typical properties of autoclave aerated concrete	25
2.8	Influence of RHA on setting times of cement at a replacement rate of 35%	30
2.9	Effect of RHA on the resistance of concrete against chloride penetration after one year of exposure to seawater	32
2.10	Preferred conditions for synthesis of crystalline CSH phases from Ca(OH)_2 and amorphous silica	34
3.1	Physical properties of raw materials	35
3.2	Chemical composition of raw materials	36
3.3	Physical properties of aluminium powder	36
3.4	Mix proportions of aerated concrete	39
3.5	Mix proportions of aerated concrete incorporating RHA	40
3.6	Mix proportions of aerated concrete incorporating RHA and AW	40
3.7	The pore-forming reaction time for aerated concrete incorporating RHA.	40
3.8	The pore-forming reaction time for aerated concrete incorporating RHA and AW.	41
4.1	Compressive strength and dry density results of aerated concrete with the various aluminium powder dosages at 7 days	46
5.1	Thermal conductivity of RHC	66
5.2	Chemical analysis by SEM-EDS at 180°C for 18 h	71

LIST OF TABLES (Cont')

Table	TITLE	PAGE
6.1	The comparison between experimental results and physical requirement as accordance ASTM C1386	87
A-1	Compressive strength of non-autoclaved aerated concrete at 7 days	106
A-2	Compressive strength of non-autoclaved aerated concrete incorporating RHA at 7 days	106
A-3	Compressive strength of non-autoclaved aerated concrete incorporating RHA at 14 days	107
A-4	Compressive strength of non-autoclaved aerated concrete incorporating RHA at 28 days	107
A-5	Compressive strength of autoclaved aerated concrete incorporating RHA at 140°C for 4 h	108
A-6	Compressive strength of autoclaved aerated concrete incorporating RHA at 140°C for 8 h	108
A-7	Compressive strength of autoclaved aerated concrete incorporating RHA at 140°C for 18 h	109
A-8	Compressive strength of autoclaved aerated concrete incorporating RHA at 160°C for 4 h	109
A-9	Compressive strength of autoclaved aerated concrete incorporating RHA at 160°C for 8 h	110
A-10	Compressive strength of autoclaved aerated concrete incorporating RHA at 160°C for 18 h	110
A-11	Compressive strength of autoclaved aerated concrete incorporating RHA at 180°C for 2 h	111
A-12	Compressive strength of autoclaved aerated concrete incorporating RHA at 180°C for 4 h	111
A-13	Compressive strength of autoclaved aerated concrete incorporating RHA at 180°C for 8 h	112
A-14	Compressive strength of autoclaved aerated concrete incorporating RHA at 180°C for 18 h	112

LIST OF TABLES (Cont')

Table	TITLE	PAGE
A-15	Compressive strength of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 4 h	113
A-16	Compressive strength of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 8 h	114
A-17	Compressive strength of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 18 h	115
B-1	Dry density of non-autoclaved aerated concrete at 7 days	116
B-2	Dry density of non-autoclaved aerated concrete incorporating RHA at 28 days	116
B-3	Dry density of autoclaved aerated concrete incorporating RHA at 140°C for 4 h	117
B-4	Dry density of autoclaved aerated concrete incorporating RHA at 140°C for 18 h	117
B-5	Dry density of autoclaved aerated concrete incorporating RHA at 160°C for 4 h	118
B-6	Dry density of autoclaved aerated concrete incorporating RHA at 160°C for 18 h	118
B-7	Dry density of autoclaved aerated concrete incorporating RHA at 180°C for 4 h	119
B-8	Dry density of autoclaved aerated concrete incorporating RHA at 180°C for 8 h	119
B-9	Dry density of autoclaved aerated concrete incorporating RHA at 180°C for 18 h	120
B-10	Dry density of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 4 h	120
B-11	Dry density of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 8 h	121
B-12	Dry density of autoclaved aerated concrete incorporating RHA and Al-containing waste at 180°C for 18 h	122

LIST OF TABLES (Cont')

Table	TITLE	PAGE
E-1	Physical requirement of AAC product	125

LIST OF FIGURES

Figure	TITLE	PAGE
2.1	Wet process kiln	9
2.2	Dry process kiln	10
2.3	Compressive Strength of the main compounds of Portland cement	14
2.4	Rate of heat hydration of Portland cement	16
2.5	Schematic representation of the formation and hydration of Portland cement	17
2.6	Rate of heat evolution during the hydration of C_3S	18
2.7	Rate of heat evolution during the hydration of C_3A	20
2.8	Aluminium processes	27
2.9	Schematic diagram of the low pressure process	28
2.10	Compressive strength of RHA and OPC	31
2.11	Phases relations of hydrated calcium silicates under hydrothermal treatment	33
3.1	Experimental scheme	38
3.2	Schematic diagram of SEM	42
3.3	Heat flow meter apparatus	44
4.1	Relationship between dry density of aerated concrete and aluminium powder dosages at 7 days	47
4.2	Relationship between compressive strength of aerated concrete and aluminium powder dosages at 7 days	48
4.3	Relationship between dry density and CaO dosages at 7 days	49
5.1	The XRD pattern of RHA	53
5.2	The compressive strength results of non-autoclaved aerated concrete	54
5.3	The effect of curing conditions on compressive strength	55
5.4	The effect of curing conditions on dry density	56
5.5	XRD pattern of aerated concrete at 28 days	57
5.6	XRD pattern of autoclaved aerated concrete at 180°C for 8 h	58
5.7	The morphology of aerated concrete at 28 days	59

LIST OF FIGURES (Cont')

Figure	TITLE	PAGE
5.8	The morphology of autoclaved aerated concrete at 180°C for 8 h	60
5.9	The compressive strength results of final AAC products at 180°C	61
5.10	The compressive strength results of final AAC products at 160°C	62
5.11	The compressive strength results of final AAC products at 140°C	62
5.12	The effect of autoclaving temperatures and times of RHC75 on compressive strength	63
5.13	The effect of autoclaving time on dry density	65
5.14	The effect of autoclaving temperatures and times of RHC75 on dry density	65
5.15	XRD pattern of autoclaved aerated concrete at 180°C for 2 h	68
5.16	XRD pattern of autoclaved aerated concrete at 180°C for 18 h	69
5.17	The morphology of AAC products at 180°C for 2 h	70
5.18	The morphology of AAC products at 180°C for 18 h	71
5.19	XRD pattern of autoclaved aerated concrete at 140°C for 4 h	73
5.20	XRD pattern of autoclaved aerated concrete at 140°C for 18 h	74
5.21	XRD pattern of autoclaved aerated concrete at 160°C for 4 h	75
5.22	XRD pattern of autoclaved aerated concrete at 160°C for 18 h	76
5.23	The morphology of AAC products at 140°C for 4 h	76
5.24	The morphology of AAC products at 140°C for 18 h	77
5.25	The morphology of AAC products at 160°C for 4 h	78
5.26	The morphology of AAC products at 160°C for 18 h	79
6.1	The particle size distribution of AW	82
6.2	The relationship between the amount of metallic aluminium and the volume of hydrogen gas	83
6.3	Dry density of AWC specimens	85
6.4	Compressive strength of AWC specimens	86
6.5	XRD pattern of AWC at 4 h	88
6.6	XRD pattern of AWC at 18 h	89
6.7	SEM micrograph of AWC specimens at 4 h	90

LIST OF FIGURES (Cont')

Figure	TITLE	PAGE
6.8	The morphology of AAC containing 20% high fineness AW during moulding. (a) at 30 min and (b) at 3 h	91
6.9	SEM micrograph of AWC specimens at 18 h	92
C-1	Thermal conductivity analysis of AAC at temperature of 180°C for 8 h	123

NOMENCLATURES

hr	=	hour
kg	=	kilogram
m ³	=	cubic meter
m ²	=	square meter
C	=	Celsius
MPa	=	Mega Pascal
RHA	=	Rice Husk Ash
AW	=	Aluminium-containing Waste
OPC	=	Ordinary Portland Cement
XRD	=	X-ray Diffraction
SEM	=	Scanning Electron Microscopy
EDX	=	Energy Dispersive X-ray Spectrometer
XRF	=	X-ray Fluorescence
MIP	=	Mercury Intrusion Porosimetry
W/B	=	Water/Binder
S/B	=	Sand/Binder
AAC	=	Autoclave Aerated concrete
ASTM	=	American Society for testing and Materials
DTA	=	Differential Thermal Analysis
W/mK	=	Watts per meter Kelvin