FLEXURAL BEHAVIOUR OF LIGHTWEIGHT PRECAST REINFORCED CONCRETE SLAB WITH BRC

NURLIANA BINTI BAHRON

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG



STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature) Full Name : NURLIANA BINTI BAHRON ID Number : AA13218 Date : 19 JUNE 2017

FLEXURAL BEHAVIOUR OF LIGHTWEIGHT PRECAST REINFORCED CONCRETE SLAB WITH BRC

NURLIANA BINTI BAHRON

Thesis submitted in fulfillment of the requirements for the award of the Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2017

ACKNOWLEDGEMENTS

Alhamdulillah all praise is for Allah, the Most Gracious, the Most Merciful who guide us to the straight way and get me through thick and thin in finishing this project.

I would like to express my appreciation and gratitude to my supervisor, Encik Mohammad Amirulkhairi bin Zubir, who have guided, supported and gave his full support to me throughout this study. With all his support and constant encouragement, I managed to complete this study very well and on time.

Besides that, my appreciation goes to both my panels, Dr Mohd Irwan bin Adiyanto and Dr Gul Ahmed Jokhio who gave me all the valuable advice and suggestions, as well as all the lessons needed to be a good engineer. This give me the opportunity to learn in a more effective way and fulfill the requirement in this study.

My appreciation to lecturers from Faculty of Civil Engineering and Earth Resources who did all the work in teaches us to have better performance in conducting presentation and on how to write an excellent thesis.

Not to forget, my special thanks to all the technicians from Concrete Laboratory, Encik Haji Muhammad Nurul Fakhri bin Rusli for giving me advices on conducting experimental work, Encik Mohd Hafiz al-Kasah bin Jamal Akhsah, Encik Kamarul Azri bin Harun, Encik Muhammad Fadzil bin Mohd Nong and Encik Mohamad Hafiez bin Abdullah for guided me in formwork making, Encik Zu Iskandar bin Kamarudin who assist me to collect my waste material for concrete and gave me all their useful advices in handling the materials and machines in laboratory.

In addition, I would like to thank all my friends especially Afiqah Fairuz Mahmud, Norlila Omar, Nur Iffah Izzati Aziz, Nur Izzah Nasri, Mohd Shafiq Mohd Zin, Izzat Akmal Ruslee, Muhammad Azfar Bahaudin, Mohamad Amirulnain Adi, Lukman Syarif Andi Lantara, Vallienetina Ejah and Mohamed Luqman Mohamed Roslan for their contribution and support in helping me with the laboratory works. I wish for your future endeavors.

Last but not least, I would like to express my greatest appreciation to my parents and my family members for their endless support in accomplishing this study.

TABLE OF CONTENT

DEC	CLARATION		
TITI	LE PAGE		
ACK	KNOWLEDGEMENTS	ii	
ABS	TRAK	iii	
ABS	TRACT	iv	
TAB	BLE OF CONTENT	v	
LIST	Г OF TABLES	vii	
LIST	Γ OF FIGURES	viii	
LIST	LIST OF SYMBOLS i		
LIST	Γ OF ABBREVIATIONS	X	
СНА	APTER 1 INTRODUCTION	1	
1.1	Introduction	1	
1.2	Background Of Study	2	
1.3	Problem Statement	3	
1.4	Research Objectives	4	
1.5	Scopes Of Research	4	
1.6	Research Significance	4	
1.7	Conclusion	5	
СНА	APTER 2 LITERATURE REVIEW	7	
2.1	Introduction	7	
2.2	Concrete	8	

2.3	Raw M	Aaterial	9
	2.3.1	Cement	9
	2.3.2	Aggregate	10
	2.3.3	Water And Admixtures	10
2.4	Oil Pa	lm	11
	2.4.1	Properties Of Palm Kernel Shell	11
2.5	Crum	o Rubber	12
	2.5.1	Properties Of Crumb Rubber	12
2.6	Fresh	Concrete	13
2.7	Harde	ned Concrete	13
2.8	Curing Of Concrete		14
2.9 Compressive Strength Test		ressive Strength Test	15
	2.9.1	Concrete With Cement Replacement	16
	2.9.2	Concrete With Fine Aggregate Replacement	16
	2.9.3	Concrete With Coarse Aggregate Replacement	17
2.10	Palm	Kernel Shell As Aggregate Replacement	18
2.11	Fcrumb Rubber As Aggregate Replacement		19
2.12	Lightv	veight Concrete Apply As Structure	20
	2.12.1	Beam Structure	22
	2.12.2	Column Structure	22
	2.12.3	Slab Structure	23
2.13	Concl	usion	24
CHAI	PTER 3	METHODOLOGY	25
3.1	Introd	uction	25
3.2	Exper	imental Procedure	26

3.3	Mater	ial Preparation	27
	3.3.1	Ordinary Portland Cement (OPC)	28
	3.3.2	Fine Aggregate	28
	3.3.3	Coarse Aggregate	29
	3.3.4	Water	29
	3.3.5	Oil Palm Kernel Shell	30
	3.3.6	Crumb Rubber	30
3.4	Concr	ete Mix Design	31
3.5	Labor	atory Testing	33
	3.5.1	Compressive Strength Test	33
	3.5.2	Flexural Test	35
3.6	Concl	usion	36
	DUED		
СНА	PTER 4	RESULTS AND DISCUSSION	37
4.1	Introd	uction	37
4.2	Concr	ete Density	37
	4.2.1	Palm Kernel Shell	37
	4.2.2	Crumb Rubber	38
	4.2.3	Comparison between Mean Density of PKS Specimens and	
		Rubber Specimens	40
4.3	Comp	ressive Strength Test	41
	4.3.1	Palm Kernel Shell	41
	4.3.1 4.3.2	Palm Kernel Shell Crumb Rubber	41 42
4.4	4.3.2 4.3.3	Crumb Rubber	42

	4.5.1	Load-Deflection Behaviour	48
	4.5.2	Mode of Failure	49
4.6	Concl	usion	53
CHAI	PTER 5	5 CONCLUSION	54
5.1	Introd	luction	54
5.2	Concl	usion	54
5.3	Recon	nmendations	56
REFE	ERENC	CES	58
APPE	NDIX	Α	62
APPENDIX B			64
APPENDIX C		65	
APPE	NDIX	D	66

LIST OF TABLES

Table 2.1	Comparison of Aggregates Properties	11
Table 2.2	Properties of Material	13
Table 3.1	Mix Proportion for PKS	31
Table 3.2	Mix Proportion for Crumb Rubber	33
Table 4.1	PKS Concrete Density Result	38
Table 4.2	CR Concrete Density Result	39
Table 4.3	Percentage Differences between PKSC and CRC Density Result	40
Table 4.4	Average Compressive Strength, $f_{cu,ave}$ of PKS Concrete	41
Table 4.5	Average Compressive Strength, $f_{cu,ave}$ of CR Concrete	42
Table 4.6	Result for Slab Testing	51
Table 4.7	Result for Slab Testing	51

LIST OF FIGURES

Figure 2.1	The Oil Palm and Its Shell 1	
Figure 2.2	Recycled Crumb-tire Aggregates	
Figure 2.3	Comparison of Compressive Strength (MPa) at 7, 14, and 28 days of Curing 1	
Figure 2.4	Comparison of Density Values (kg/m ³) of Different Sizes of Crumb Rubber Particles	, 19
Figure 2.5	Compressive Strength Results	20
Figure 3.1	Research Flow Chart	26
Figure 3.2	Ordinary Portland Cement	28
Figure 3.3	Sand	28
Figure 3.4	Natural Granite	29
Figure 3.5	Tap Water	29
Figure 3.6	Oil Palm Kernel Shell	30
Figure 3.7	Crumb Rubber	30
Figure 3.8	Compression Testing Machine	35
Figure 3.9	Test Set Up	36
Figure 3.10	Magnus Frame	36
Figure 4.1	Crushing of R50 Cube Specimens	43
Figure 4.2	Graph of Compressive Strength against Percentage of PKS	44
Figure 4.3	Graph of Compressive Strength against Percentage of CR	45
Figure 4.4	Graph of Compressive Strength against Percentage between PKSC and CRC at 28 Days of Curing	46
Figure 4.5	Graph of Load against Deflection	48
Figure 4.6	The Bending Effect in Replacement Slab R10	50
Figure 4.7	Cracking Pattern of Replacement Slab R10	50
Figure 4.8	Flexural Failure of Control Slab	52
Figure 4.9	Cracking Pattern of Control Slab	53
Figure 4.10	Flexural Failure of All Three Different Slab (from top to bottom: CRC, PKSC and Control Slab)	53
Figure 4.11	Preparation of Concrete Slab Testing	62
Figure 4.12	Cracking Failure for Slab CM	62
Figure 4.13	Cracking Failure for Slab R10	63
Figure 4.14	Cracking Failure for Slab K10	63

LIST OF SYMBOLS

%	Percentage
mm	Millimeter
g	Gram
kg	Kilogram
kN	Kilo Newton
°C	Degree Celcius
w/c	Water to Cement Ratio
MPa	Mega Pascal
kg/m ³	Kilogram per Meter Cube
m ³	Meter Cube

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
ACI	American Concrete Institute
BS	British Standard
СМ	Control Mix
CR	Crumb Rubber
PKS	Palm Kernel Shell
K10	Concrete with 10% PKS Replacement
K20	Concrete with 20% PKS Replacement
K30	Concrete with 30% PKS Replacement
K40	Concrete with 40% PKS Replacement
K50	Concrete with 50% PKS Replacement
R10	Concrete with 10% CR Replacement
R20	Concrete with 20% CR Replacement
R30	Concrete with 30% CR Replacement
R40	Concrete with 40% CR Replacement
R50	Concrete with 50% CR Replacement