THE COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF COCONUT SHELL AS PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE WITH DIFFERENT CURING METHOD

LAU JETT CHEN

B.ENG (HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG

THE COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF COCONUT SHELL AS PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE WITH DIFFERENT CURING METHOD

LAU JETT CHEN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
B.Eng (Hons) in Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2017

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering (Hons.) Civil Engineering.

Signature :
Name of Supervisor : DR. DOH SHU ING
Position : SENIOR LECTURER
Date : 03 January 2017

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature :
Name : LAU JETT CHEN
ID Number : AA13264
Date : 3 January 2017

Dedicated to my parent,
for their devotion and love
make me be who i am today

ACKNOWLEDGEMENTS

Apart from the efforts of me, the success of this final year project depends largely on the encouragement and guidelines given by many knowledgeable and experienced peoples from University Malaysia Pahang. I would like to take this opportunity to express my heartfelt gratitude to those people who have been generously providing their valuable information and experience for the successful completion of this project.

First of all, I would like to show my greatest appreciation to my supervisor, Dr Doh Shu Ing. I can't say thank you all enough for tremendous support and help from PSM 1 to PSM 2 for my University life. I feel motivated and encouraged every time I have discussion with Dr Doh on the research problems. Without his encouragement and guidance this research would not have been materialized. Besides that, I would like to thanks Dr Doh, for his patience in giving me guidance in project works.

Furthermore, I would like to thank to my final year project presentation's panel, Dr Fadzil bin Mat Yahaya and Mr. Khalimi Johan bin Abd Hamid who give suggestion on my study to improve the objective of my study. In addition I would like to thank to my friends who helping me on this study. They are Tan Yong Chuah, Tan Chin Sheng, and Tan Shu Mei. They have given a lot of helping on my study in sharing knowledge and casting work in laboratory.

Last but not least, I would like to thanks my parent who has been constantly giving me the support and encouragement every time when I was stressed with the workloads that are given to me. Without their support, I would not have been able to complete my final year project with good compliments from my supervisor. I am grateful and very much appreciated for what they have been given to me.

TABLE OF CONTENTS

CHAPTER 4 RESULT AND DISCUSSION

CHAPTER 5 CONCLUSION AND RECOMMENDATION

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

%	Percentage
Φ	Diameter
°C	Celsius
P	Maximum load that carried by beam specimens (N)
L	Length of beam span (mm)
b	Average width of specimen at the fracture (mm)
d	Average depth of specimen at the fracture (mm)
σ	Splitting tensile strength (N/mm^2)
F	Maximum load carried by cylindrical specimen (N)
l	Length of the cylindrical specimen (mm)
D	Cross-sectional diameter of cylindrical specimen (mm)
R^2	Coefficient of determination

LIST OF ABBREVIATIONS

RM	Ringgit Malaysia
BS	British Standard
FA	Fine Aggregate
CA	Coarse Aggregate
w/c	Water Cement ratio
mm	Millimetre
N/mm^2	Newton per millimetre square
Kg	Kilogram
N	Newton
MPa	Mega Pascal
EN	European Standard
CSC	Coconut Shell Concrete
WC	Water curing
AC	Air dry curing
EC	Environmental Curing
No	Number
CaO	Calcium oxide
NaOH	Sodium Hydroxide
Na2O	Sodium Oxide
OPC	Ordinary Portland cement
CS	Coconut Shell
ASTM	American Society for Testing and Materials
IS	Indian standard

THE COMPARATIVE STUDY OF MECHANICAL PROPERTIES OF COCONUT SHELL AS PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE WITH DIFFERENT CURING METHOD

LAU JETT CHEN

Thesis submitted in fulfillment of the requirements
for the award of the degree of
B.Eng (Hons) in Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2017

ABSTRACT

Coconut is one of the most important agriculture products in Malaysia, after the coconut had been processed the coconut wastes were moved to the land fill. Coconut shell is one of the part from the coconut waste, it is very durable and it need a very long to biodegrade. Due to the slow biodegrade speed, the coconut wastes become one of the top of waste in Malaysia. The coconut Waste raises the landfill capacity in Malaysia. The coconut shell is very durable and hard so partial replace coconut as fine aggregate will reduce the land fill and also the pollution that cause by sand mining. The objective of this study is to analysis the effect of curing methods to mechanical properties of concrete by partial replaced fine aggregate as coconut shell with 3 different type of curing method (water, environmental, air dry). The test that had been carried out for the research are slump test, sieve analysis, compressive strength test, flexural strength test and splitting tensile test. This study is partial replaced the fine aggregate with coconut shell powder with 0%, 10% and 20% with 3 different type of curing method. The 20% of coconut shell powder concrete with water curing get the best compressive strength for day 60 which is 42.241kN/mm2 and flexural strength is 12.818kN/mm2. Water curing method get the best result next is air dry curing and the last is environmental curing. The coconut shell concrete got lower strength compare to normal concrete, however the CSC 10 and CSC 20 had been achieved the designed strength so the coconut concrete still able to use in construction. By reusing the coconut shell as partial fine aggregate replacement into concrete mix design, it reduce the amount of agriculture waste and reduce the usage of the sand.

ABSTRAK

Kelapa adalah salah satu produk pertanian yang sangat penting di Malaysia, selepas kelapa telah diproses sisa kepala akan membuang ke tapak pelupusan. Tempurung kelapa adalah salah satu bahagian daripada sisa kepala, tempurang kelapa sangat tahan lama and susah biodegradasi. Disebeb oleh kelajuan biodegradasi kelapa yang pelahan, sisa kelapa menjadi salah satu sampah utama di Malaysia. Sisa kelapa meningkatkan kapasiti tapak pelupusan di Malaysia The coconut Waste raises the landfill capacity in Malaysia. Tempurung kelapa adalah sangat tahan lama dan keras oleh itu, separa menggantikan tempurung kelapa sebagai agregat halus akan mengurangkan kapasiti tapak pelupusan dan juga pencemaran yang menyebabkan oleh perlombongan pasir. Objektif kajian ini adalah untuk analisis kesan kaedah pengawetan konkrit untuk sifat-sifat mekanikal konkrit separa agregat halus digantikan sebagai tempurung kelapa dengan 3 jenis kaedah penawatan concrete yang berbeza (air, alam sekitar, udara kering). Ujian yang telah dijalankan untuk kajian ini ialah ujian kemerosotan, analisis ayak, ujian kekuatan mampatan, ujian kekuatan lenturan dan ujian membelah tegangan. Kajian ini, akan separa menggantikan agregat halus dengan serbuk tempurung kelapa dengan 0%, 10% dan 20%, dengan 3 jenis kaedah pengawetan yang berbeza. CSC 10/WA mendapatkan kekuatan mampatan yang terbaik untuk hari 60 ialdh 42.241 kN /mm^2 dan lenturan kekuatan adalah 12.818kN /mm^2. Kaedah pengawetan air mendapatkan hasil yang terbaik seterusnya adalah pengawetan kering dan yang terakhir adalah pengawetan alam sekitar. CSC mendapat kekuatan yang lebih rendah berbanding dengan konkrit biasa, tetapi CSC 10 dan CSC 20 telah mencapai kekuatan direka dan konkrit kelapa masih mampu untuk digunakan dalam pembinaan. Dengan menggunakan semula tempurung kelapa sebagai sebahagian penggantian agregat halus ke dalam campuran konkrit, ia mengurangkan jumlah sisa pertanian dan mengurangkan penggunaan pasir.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF RESEARCH

Coconut is one of the most important agriculture products in Malaysia. Coconut is at the rank of fourth in term of total plating area and the first is oil palm, second is rubber third is paddy (Sivapragasam, 2008). In Malaysia there are five main state that are the main coconut producer that are Perak (15,180 hectare), Johor (21,250 hectare), Selangor (10,320 hectare) , Sarawak (22,290 hectare) and Sabah (19,150 hectare). Coconut is a very useful plant, the part that can use from coconut plant are roots, stems, nuts, leaves and even other components from the trees. Coconut Milk is produce by the coconut fruits and it is main target for food product in Malaysia, and coconut milk is the essential ingredient that most use in Malay dishes in Malaysia for example curry, and dessert (Alexander, J 2006). Coconut shell is a bio- degradable material but it is durable and strong so it needs a long time to bio-degrade. Beside that coconut shell also had been reuse as natural bowl, coconut shell charcoal, and also hand craft.

Coconut waste now had been become a large amount of waste in Malaysia, According Rice and Industrial Crops Centre (MARDI) and stated that in years 2007 Malaysia had produce 382000 tons of coconut with total 109185 hectare of land that are using for planting the coconut trees. There are about 63 % of the coconut is providing for Malaysia local use and 37 % is providing for export to other country and industry used. Besides that Malaysia also import RM 404, 517, 380 value of coconut from over sea example Indonesia and Philippines (Sivapragasam, A, 2008). From the data, it show that Malaysia is a country that having high consumption of coconut. Agriculture

and Agro-based Industry Minister Datuk Seri Ismail Sabri Yaakob reported that 30,000 hectare of land was needed to extra produce 72million of coconut in a year due to the high consumption of coconut in Malaysia, and he said that present coconut that produce by Malaysia only 539 million of fruits in a year but Malaysia are consume 611 million of coconut in a year there is 72 million of coconut different (TheStar, 2014). High consumption of coconut will produced high amount of coconut waste, it will increase the load for the land fill in Malaysia.

Sand is a very important material that are using in mix concrete design. The sand is act as the fine aggregate in the concrete, and the use of fine aggregate is use to bind the cement with the coarse aggregate. In addition sand also use to fill in the spaces that left between the coarse aggregate and to stick the coarse aggregate together (Day,K., 2003). In Malaysia budget 2016, Datuk Seri Najib Tun Razak concluded that PR1MA will build 175,000 houses in all the state in Malaysia which will be sold at 20 % below market prices and the total cost for the development of PR1MA is of RM1.6 billion (Thestar, 2015). The housing project need a huge amount of the usage of sand to construct the structure， due to the high usage of sand as fine in the concrete mix and it is straight effected the reduced of sand capacity in earth and the sand mining activity is increased . Sand mining is affecting the environment problem to Malaysia example Land losses due to the erosion by the mining. Besides that the river is polluted during the sand mining, and the water level for the river is decreased due to the sand had been excavated (UNEP, 2014).

For the research by reusing the coconut shell as partial fine aggregate replacement into concrete mix design, it can bring a lot of advantages to the construction field, environment and so on. It can reduce the capacity of land filling problem, reducing the usage of sand in construction and also reduce the sand mining activities.

1.2 PROBLEM STATEMENT

Coconut is one of the most high consumption fruit that use in Malaysia and consumed about 611 million of coconut in a year, due to the high consumption of coconut in Malaysia it produced large amount of coconut waste in Malaysia. Coconut shell is a bio- degradable material but it is durable and strong so it needs a long time to bio-degrade. The statement is stated by Little Cherry Ltd, this company are selling natural coconut shell in the description it stated that coconut shell are oil proof, waterproof, durable, durable , robust and can be washed over and over (Little Cherry Ltd). Due to the high durability and slow bio degradable of coconut shell, it will cause burden to the landfill capacity problem in Malaysia. The large amount of coconut waste will retain at the land fill for long time due to the high durability of coconut shell and it will cause the increasing number of landfill in Malaysia. Jabatan Pengurusan Sisa Pepejal Negara (JPSPN) stated that, all the non-recyclable waste will transfer to the landfill, and the landfill problem will cause environment and human health issue to Malaysia.

The waste management system in Malaysia is still poor compare to other country example Singapore, due to lack of technology on waste management, so JPSPN having problem environment problem in landfilling. In Malaysia having 261 unit of the land fill, only 150 of the land fill operating and the 111 unit of land is fully loaded with the solid waste, the number of the landfill is increasing year by year, and the land is causing a lot of problem to earth and also human living (Nur Shaylinda Mohd ZinHamidi, 2012). One of the effects from landfill are Greenhouse Gas Pollution, the broke down of organic material will released methane into the open air. The methane gas that produced from landfill is about 12% of total global methane released and it is about 5 % from total greenhouse gas emissions in the earth. In year 2012 Peninsular Malaysia is generated 25000 ton of waste and about forty 7 % of the waste is organic waste. Only 5 % of the waste had been recycled. By reusing the coconut shell in construction field, it can reduce the waste capacity of landfill and also the environment pollution in Malaysia.

REFERENCES

This guide is prepared based on the following references;

Alexander, James. 2006. Malaysia Brunei & Singapore. *New Holland Publishers*.

Adam, Arham, A. Horianto. 2014. The effect of temperature and duration of curing on the strength of fly ash based geopolymer mortar. *Procedia Engineering*, 410-414.

Ali,M.,Li, X.,Chouw,N. 2013. Experimental investigations on bond strength between coconut fibre and concrete. *Materials & Design.***44**.596-605

Aslama,M.,Shafigh,P., Jumaat,M.Z. 2016. Drying shrinkage behaviour of structural lightweight aggregate concrete containing blended oil palm bio-products. *Journal of Cleaner Production*. **127**.183-194

Budget 2016: Full speech by PM Najib. 2016. *The Star*. 23 October

CFA. *Cracking In Concrete Wall.* North Wmerica: Association, Concrete Foundations.

Claudio,d.S.K.,Metz,D.A.,Frohlich,D.G. 2010. Influence of Water Absorption in the Performance of Mortars Made with Manufactured Fine Aggregates.

Cordeiro,G.C.,Alvaraenga,L.M.S.C.,Rocha,C.A.A. 2016. Rheological and mechanical properties of concrete containing crushed granite fine aggregate. *Construction and Building Materials*.**111.**766-733

Chowdhury, S., Mihir,M., Om 2015. The incorporation of wood waste ash as a partial cement replacement material for making structural grade concrete: An overview. *Ain Shams Engineering Journal*.6(2): 429-437

Colorado, H., A. Garcia,E., Buchely,M,F (2016). White Ordinary Portland Cement blended with superfine steel dust with high zinc oxide contents. *Construction and Building Materials*.**112.** 816-824

CRMCA. 2003. CIP36- Structure Lightweight Concrete. *Concrete in Practice*.

Controversial Johor Strait land reclamation project Forest City gets the go-ahead. 2015. *Straitstimes*.14 January

Day, K. 2003. Concrete Mix Design, Quality Control and Specification. *CRC Press*.

Denneman, E., Kearsley,E.P.,Visser,A.T. Splitting tensile test for fibre reinforced concrete. *Material and structures*. **44**(8):1441-1449

Dilli,M.E.,Atahan,H.N 2015. A comparison of strength and elastic properties between conventional and lightweight structural concretes designed with expanded clay aggregates. *Construction and Building Materials*.**101**.260-267

Fan, C.C.,Huang, R.,Hwang,H.,Chao,S.J. 2016. Properties of concrete incorporating fine recycled aggregates from crushed concrete wastes. *Construction and Building Materials*.**117**.708-715

Fraternali, F., Spadea,S., Berardi,V.P. 2014. Effects of recycled PET fibres on the mechanical properties and seawater curing of Portland cement-based concretes. *Construction and Building Materials*.**60**. 293-302.

Gong, Y., Fang,Y. 2016. Preparation of belite cement from stockpiled high-carbon fly ash using granule-hydrothermal synthesis method. *Construction and Building Materials*.**111**.175-181

Gunasekaran,K.,Ramasubramani,R.,Annadurai,R., Chandar,S.P. 2014. *Study on reinforced lightweight coconut shell concrete beam behavior under torsion*.**57**.374-382

Hay,A. Shaban,A. 2015. Properties of recycled concrete aggregate under different curing conditions. *HBRC Journal*.

Kharita, M.H.,Yoused,S., Alnassar,M.2010. The effect of the initial water to cement ratio on shielding properties of ordinary concrete. *Progress in Nuclear Energy*.**52**(5):491-493

Kore, S.D.,Vyas,A.K., 2016. Impact of Marble Waste as Coarse Aggregate on properties of lean cement concrete. *Case Studies in Construction Materials*.**4**.85-92

Kupwade,P.K, Alaibani,A.F.,Abdulsalam,M.F.,Mao,C.,Bumajud,A.,Palkovic,S.D. (2016). Microstructure of cement paste with natural pozzolanic volcanic ash and Portland cement at different stages of curing. *Construction and Building Materials*.**113**.423-441

Little Cherry Ltd. (n.d.). Retrieved from https://www.littlecherry.co.uk/Disposable-Party-Plates-And-Cutlery/Palm-Leaf-Plates-And-Bowls/Natural-Coconut-Shell-Bowl-10-Pack

Medium.Html?search_in_description=1&keyword=coconut&cPath=141

More land needed to raise coconut production and meet demand. 2014. *The Star*. 15 December

Mahyuddin Ramli, W. H. 2013. Strength and durability of coconut-fiber-reinforced concrete in aggressive environments. Construction and Building Materials.**38**.554-56

Mohamed, H. A. 2011. Effect of fly ash and silica fume on compressive strength of self-compacting concrete under different curing conditions. *Ain Shams Engineering Journal*. **2**.(2):79-86.

Muhammed, H. S.,Kadum,K.T., Ahmad,M.A., Getfan,N.,Zehra,A.A. 2014. Effect of Fine Materials on the Compressive Strength and Workability of Concrete. *Kufa journal of Engineering*. **4**. 137-156.

NRMCA. 2000. CIP-16 Flexural Strength Test.

NRMCA. 2000. *Concrete in Practice- Curing in Placed Concrete.*

NRMCA. 2003. CIP35- TestingCompressive Strengthof Concrete.

Paulik, P. 2013. The effect of curing conditions (In Situ vs. Laboratory) on compressive strength development of high strength concrete. *Procedia Engineering*.**65**. 113-119.

Rubene,S.,Vilnitis,M. 2014. Use of the Schmidt rebound hammer for non destructive concrete structure testing in field. *Czasopismo Techniczne*. 1-B (5):13-19

Sivapragasam, A. 2008. Coconut in Malaysia-current developments and potential for re-vitalization. *2nd International Plantation Industry Conference and Exhibition (IPICEX 2008), Shah Alam, Malaysia.* 18-21.

Shaylinda, N. Aziz, A .Hamidi. Adlan, M,N. Ariffin, A. 2012. CHARACTERIZATION OF LEACHATE AT MATANG LANDFILL. *Academic Journal of Science*. 317-322

Stop reclamation projects. 2013. *The Star*. 23 October

Sutan,N.M.,Meganathan,M. 2013. A COMPARISON BETWEEN DIRECT AND INDIRECT METHOD OF ULTRASONIC PULSE VELOCITY IN DETECTING CONCRETE DEFECTS. *Journal of Nondestructive Testing*.**8**.(5) 1-9.

Singh, S.B., Munjal,P., Thammishetti,N. 2015. Role of water/cement ratio on strength development of cement mortar. *Journal of Building Engineering*.**4**.94-100

Singh, S. a. (2015). Role of water/cement ratio on strength development of cement mortar. *Journal of Building Engineering*. **4**. 94-100.

Turuallo, G., Soutsos,M.N. 2015. Supplementary Cementitious Materials: Strength Development of Self-compacting Concrete Under Different Curing Temperature. *Procedia Engineering*.**125**. 699-704.

Yerramala, A., Ramachandrudu, C. 2012. Properties of concrete with coconut shells as aggregate replacement. *International journal of engineering inventions*.**1**(6):21-23.