THE PROPERTIES OF CEMENT-SAND BRICK CONTAINING VARIOUS PERCENTAGE OF COCKLE SHELL AS A PARTIAL SAND REPLACEMENT

SHAHRUL MUNIR BIN ABDUL NASIR

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SUPERVISOR'S DECLARATION

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

Signature : 

Name of Supervisor : DR. KHAIRUNISA BT MUTHUSAMY

Position : SENIOR LECTURER

Date : 23rd JUNE 2016

STUDENT'S DECLARATION

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

Signature : 
Name : SHAHRUL MUNIR BIN ABDUL NASIR
ID Number : AA12259
Date : 23rd JUNE 2016

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ABSTRACT

The increasing demand of cement-sand brick in construction industry nowadays has led to the over-exploitation of natural sand. At the same time, the availability of cockle in this country is relatively high with 43013 metric tonnes of cockle, landed in the year 2014 alone. Furthermore, cockles are often deemed as a form of waste and have no apparent substantial direct use. Nonetheless, cockle shells have been seen as a replacement for natural sand in cement-sand brick production and in turn reduce the abundant of cockle shell waste at disposal area. This thesis presents the mechanical properties of cement-sand brick that consist of a variety of cockle shell percentage as a partial sand replacement. The sand was replaced by 0%, 10%, 20%, 30%, 40% and 50% of cockle shell (CS) replacement. The size of the specimens that were used is 210 x100 x 65 (length x width x height). The specimens were then subjected to two types of curing method, namely water and air curing for a period of 7, 28 and 60 days. Subsequently, the specimens were tested for compressive strength, flexural strength and water absorption tests. The compressive strength and flexural strength reached its maximum value at 30% of CS replacement, which suggests that the air curing method delivers the best results for both tests as compared to the water curing method. The strength was also observed to increase as the curing age is increased. As for water absorption test, the results obtained are in accordance to the ASTM C55-11. Success in combining waste from fisheries industry in the cement sand brick production will able to reduce the use of natural river sand and will decrease the amount of cockle shells disposed at the dumping site.

ABSTRAK

Peningkatan permintaan bata pasir dalam industri pembinaan pada masa kini telah membawa kepada pengeksploitasian pasir semulajadi secara berlebihan. Disamping itu, pengeluaran kerang di negara ini agak tinggi dengan 43013 tan metrik kerang telah didaratkan pada tahun 2014 sahaja. Tambahan pula, kerang sering dianggap sebagai satu bentuk sisa buangan dan tidak mempunyai kegunaan secara langsung. Namun begitu, kulit kerang telah dilihat sebagai salah satu alternatif yang boleh menggantikan pasir semulajadi dalam penghasilan batu-bata pasir dan boleh mengurangkan sisa kulit kerang yang berlebihan di tapak pelupusan. Tesis ini membentangkan ciri-ciri bata pasir yang mengandungi pelbagai peratusan kulit kerang sebagai sebahagian bahan gantian pasir. Pasir telah digantikan dengan 0%, 10%, 20%, 30%, 40% dan 50% kulit kerang. Saiz spesimen yang digunakan adalah 210 x 100 x 65 (panjang x lebar x tinggi) dalam unit milimeter. Spesimen akan dikenakan dua jenis kaedah pengawetan iaitu pengawetan air dan udara selama 7, 28 hingga 60 hari. Setelah itu, spesimen diuji dengan ujian kekuatan mampatan, ujian kekuatan lenturan dan ujian penyerapan air. Kekuatan mampatan dan kekuatan lentur mencapai nilai maksimum pada 30% penggantian kulit kerang, yang juga menunjukkan bahawa kaedah pengawetan udara memberi hasil yang terbaik untuk kedua-dua ujian berbanding kaedah pengawetan air. Kekuatan bata juga meningkat berdasarkan tempoh pengawetan di mana semakin lama usia pengawetan, semakin tinggi kekuatan yang diperoleh. Bagi ujian penyerapan air, nilai yang diperoleh telah memenuhi syarat yang dinyatakan dalam ASTM C55-11. Kejayaan dalam menggabungkan sisa dari industri perikanan dalam penghasilan bata pasir akan dapat mengurangkan penggunaan pasir sungai semulajadi dan mengurangkan jumlah kulit kerang yang dilupuskan di tapak buangan.

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LIST OF SYMBOLS

CaC	Calcium Carbonate
Na	Sodium
Mg	Magnesium
Fe	Iron
Ca	Calcium
Cu	Copper
Ni	Nickel
Pb	Lead
P	Phosphorus
B	Boron
As	Arsenic
Al	Aluminium
Mn	Manganese
Cd	Cadmium
I	Iodine
Hg	Mercury
Si	Silicon
%	Percentage
N/mm^2	Newton per Millimeter Square
MPa	Megapascal
kg	Kilogram
g	Gram
mm	Millimetres
kg/m^3	Kilogram Per Meter Cube
^oC	Degree Celcius

LIST OF ABBREVIATIONS

CS	Cockle Shell
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
OPC	Ordinary Portland Cement
Ppb	Part per Billions
BDL	Below Detection Limit
PCC	Precipitated Calcium Carbonate
MS	Malaysian Standard
ASTM	American Society for Testing and Materials

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The growth in the construction industry in Malaysia has led to a high demand of construction material such as cement sand brick. The material used in brick production often involves natural sand that is customarily excavated from natural resources such as riverbeds, sea shelf and mines. Uncontrolled and over-exploitation of the natural resources may result in the depletion of natural resources (Bjork,1999) as well as the increase in the cost of construction materials in the future. The food industry in this country is one of the major contributors to the generation of waste such as cockle shell. Cockle is one of the important species in the aquaculture industry in Malaysia where the area of cockle aquaculture extended about 10,383.09 hectares in 2010 (Hazurina et al.,2012). The production of cockles achieved 43013 Metric tonnes in the year 2014 and this figure can be used to estimate the number of shell waste generated (Department of Fisheries Malaysia 2014).

Concerns towards these issues has led towards a variety of studies to investigate the potential of waste materials to be used as a partial replacement of construction materials. Cockle shell, has also not been excluded from such studies. This study investigates the use of cockle shell in construction materials by partially replacing it with the natural sand in cement-sand brick production.

1.2 PROBLEM STATEMENT

The increasing demand for construction materials would lead to the exploitation of natural resources such as natural sand. This will lead to more mines to be open particularly in the river banks where natural sand is often obtained. This will cause negative impacts to the environment and the people through soil erosion and the endangerment of marine life (Kosmo online, 2015). A study made in the United States reported that sand mining activity leads to the shoreline erosion (Thornton et al., 2006). Unsolicited and uncontrolled mining may also further escalate the depletion of natural resources.

In 2014, the production of cockle shell in Malaysia reached about 43013 Metric tonnes per year which is an increase of 4.35% from the previous year (Department of Fisheries Malaysia, 2014, Quantity and value of aquaculture brackish water production 2006-2014). This will lead to the generation of abundant shell waste which is detrimental to the environment. The shells that have been dumped and left untreated will cause an unpleasant odour and distorts the scenic view (Mohamed et al.,2012). To address the aforementioned problems, cockle shell has been harnessed as a partial sand replacement in the production of cement sand brick, which is expected to reduce the statistics of cockle shells waste and inadvertently contributes to the preservation of natural resources for future generation.

1.3 OBJECTIVES

This study was conducted to achieve the following objectives:

i) To investigate the compressive strength of cement-sand brick containing various percentage of cockle shell as a partial sand replacement.
ii) To investigate the flexural strength of cement-sand brick containing various percentage of cockle shell as a partial sand replacement.
iii) To investigate the water absorption of cement-sand brick containing various percentage of cockle shell as a partial sand replacement.

1.4 SIGNIFICANCE OF RESEARCH

This study shall fill in the knowledge gap on the use of cockle shell as a partial sand replacement in cement sand brick production. The success in using cockle shell as a partial sand replacement in cement sand brick is expected to reduce the statistics of cockle shell dumped as waste in Malaysia as well as preserving natural sand. In addition, the information gained from this study will provide a better understanding on the mechanical behaviour of the modified brick for further future investigation and commercialisation purpose.

1.5 SCOPE OF RESEARCH

This study was focused on the behaviour of the cement sand brick when it containing a various percentage of cockle shell as a partial sand replacement. The percentage of cockle shells used varies from 10%, 20%, 30%, 40%, and 50% by weight of sand. Two types of mixes prepared during this study, which is control mix and modified mix. The control mix consists 0% of cockle shell with 100% used of natural sand. The modified mix consist varies of cockle shell percentages used as a partial sand replacement.

The size of the samples was fixed to 210x100x65 millimetres dimension. For the curing process, the specimens were subjected to different methods of curing. The methods used for curing are air and water curing. The tests are conducted on the specimens that were completed the curing process in 7, 28 and 60 days period. The tests included are the compressive strength, flexural strength and water absorption test. The water absorption test was conducted when the specimen reached the curing age of 28 days.

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