WATER ABSORPTION AND ACID RESISTANCE OF OIL PALM SHELL LIGHTWEIGHT AGGREGATE CONCRETE CONTAINING FLY ASH AS PARTIAL CEMENT REPLACEMENT

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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.

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

Faculty of Civil Engineering & Earth Resources

UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

Assalamualaikum warahmatullahi wabarakatuh…

Alhamdullilah, with the consent of Allah SWT, I finally completed my research. I would like to dedicate my deepest appreciation and gratefulness to the following individuals:

My project supervisor, Dr. Khairunisa binti Muthusamy for her never-ending support and guidance throughout the process of completing the project. I really appreciate her consistent support in making this study possible.

I also indebted to Universiti Malaysia Pahang for providing the facilities for my study and research. A special thanks also dedicated to the technical staff of Civil Engineering Concrete Laboratory.

My beloved family that had to encourage and motivate, and their endless support in achieving success to this level.

I would like to extend my gratitude to Mohamad Safwan Bin Jaafar and Nadiah Binti Samsuddin who has help me a lot during my lab work.

ABSTRAK

Penggunaan agregat secara besar-besaran dalam industri konkrit menyebabkan pengurangan sumber alam seperti batu kelikir dan granit. Lebihan simen dalam industri pembinaan menyebabkan banyak masalah alam sekitar. Bagi meringankan kesan terhadap alam sekitar, kajian semakin tertumpu kepada penggunaan bahan dan proses berasaskan tumbuhan alternatif seperti cengkerang kelapa sawit (OPS) dan abu terbang (FA) sebagai pengganti simen separa. Kajian ini dijalankan untuk menentukan ketahanan konkrit kelapa sawit dari segi keliangan, penyerapan air dan rintangan asid dalam konkrit yang mengandungi abu terbang. Semua spesimen disediakan dan tertakluk kepada pengawetan sehingga 60 hari. Keadaan pengawetan yang digunakan adalah pengawetan udara. Keputusan menunjukkan bahawa konkrit dengan FA mempunyai kekuatan mampatan yang lebih rendah. Keliangan dan penyerapan air meningkat apabila kandungan FA digunakan bertambah. Konkrit yang mengandungi jumlah FA yang lebih besar menunjukkan lebih banyak kehilangan jisim dan kemerosotan kekuatan selepas direndam dalam larutan asid sulfurik. Secara keseluruhannya, ketahanan OPS konkrit berkurang apabila jumlah FA yang lebih besar digunakan.

ABSTRACT

The massive use of aggregates in concrete industry leads to depletion of natural stone such as gravel and granite. The overuse of cement in construction industry causes many environmental problems. In light of environmental impact, the discussion has increasingly focused on using alternative plant-based material and processes such as oil palm shell (OPS) and fly ash (FA) as partial cement replacement. This research is conducted to determine the durability of oil palm shell concrete in terms of porosity, water absorption and acid resistance in concrete containing fly ash. All the specimens were prepared and subjected to curing until 60 days. The condition of curing employed is air curing. The results demonstrate that the concrete with FA have lower compressive strength. The porosity and water absorption of concrete increase when content of FA used is increased. Concrete containing larger amount of FA exhibit higher mass loss and strength deterioration after immersed in sulphuric acid solution. Conclusively, the durability of OPS concrete reduces as larger amount of FA is used.

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LIST OF SYMBOLS

%	Percentage
Kg	Kilograms
Kg/m^3	Kilograms per metre cubes
m	Metre
m^3	Metre cubes
mm	Millimetre
MPa	Mega Pascal
w/c	Water content

LIST OF ABBREVIATIONS

Al_2O_3	Aluminium
ASTM	American Society for Testing and Materials
BS	British Standard
BS EN	British Standard European Norm
CaO	Calcium
CI	Chloride
CO_2	Carbon dioxide
C-S-H gel	Calcium Silicate Hydrate gel
FA	Fly Ash
Fe_2O_3	Iron
K_2O	Potassium
LWAC	Lightweight Aggregate Concrete
MgO	Magnesium
Mil ha	Million hectares
MOE	Modulus of Elasticity
N	Nitrogen
Na_2O	Sodium
OPC	Ordinary Portland Cement
OPS	Oil Palm Shell
S	Sulphur
SiO_2	Silica
SO_2	Sulphur dioxide

CHAPTER 1

INTRODUCTION

1.1 Introduction

Basically, concrete is one of the most essential materials used in the construction industry. Ever since the ancient day, concrete has been widely used in construction in many numbers of structures. The continuing advancements and research of concrete have resulted in the development of several kinds of concrete. Each of the concrete has its own properties fulfilling the industries requirement. Lightweight aggregates concrete (LWAC) is one of the concretes that currently has a higher demand in the construction industry. Concrete with a density range between 1600 kg/m^3 until 2000 kg/m^3 is classify as lightweight aggregate concrete (LWAC) (Newman et al. 2003). Lightweight aggregates concrete (LWAC) can reduce the weight of the structure. It allows the reduction size of the load bearing elements such as columns and foundations. Therefore, the demand of lightweight aggregates concrete has been growing for the past few years.

In Malaysia, oil palm shell (OPS) is an agricultural solid waste of lightweight aggregates to produce lightweight aggregates concrete that has been known for the past twenty years (Payam Shafigh et al. 2013). Oil palm shell (OPS) consists of small particles comes in different shapes and sizes that can be used as aggregate in concrete. The use of oil palm shell as an aggregate in concrete will produce lightweight aggregates concrete (LWAC). Fly ash (FA) is one of the pozzolanic material. It is a product of burning crushed coal in an electric generating station. Precisely, it is an unburned excess that comes from the burning zone in the boiler. Fly ash usually benefits on the strength and durability of concrete at later ages (Xu & Shi, 2018). Many studies have been conducted in the replacement level of fly ash in concrete that varies from 15% to 30%. Fly ash (FA) will be used as partial cement replacement in this research to gain a better reaction in the cementitious paste.

1.2 Problem Statement

The massive use of aggregates in the concrete industry leads to huge depletion of natural stone such as gravel and granite. The aggressive consumption will reduce the non-renewable aggregate resources if there are no control measures to be implemented (Ismail et al. 2013). In the meantime, Malaysia is one of the major producers and exporter countries of palm oil and palm oil products. For about 80 million tonnes of solid biomass waste were yielded in 2010 by the oil palm industry in Malaysia and is expected to increase to 85-110 million tonnes by 2020 (National Biomass Strategy 2020, 2015). These wastes are being dumped near the palm oil mill thus resulting in environmental pollution issues (Arunima & Sreelekshmi, 2016). At the same time, disposal of fly ash by coal power plant causes pollutions such as air pollution, water pollution, noise pollution and land degradation (Nawaz, 2013).

1.3 Objective of the Study

There are three objectives of this research. The objectives are as follows;

a) To determine the compressive strength of OPS LWAC containing fly ash as partial cement replacement.
b) To determine the acid resistance of OPS LWAC containing fly ash as partial cement replacement.
c) To determine the water absorption and porosity of OPS LWAC containing fly ash as partial cement replacement

1.4 Scope of the Study

This study is to determine the durability properties of oil palm shell lightweight aggregates (LWAC) concrete containing fly ash (FA) as partial cement replacement. The coarse aggregates inside the concrete are replaced with OPS. The OPS in this study are obtained from Kilang Sawit Panching, Pahang. 0,10,20,30 and 40 % of fly ash added in the concrete as partial cement replacement. The sample size of the concrete used in this study is 100 x 100 x 100mm cube. The hardened concretes were cured by air curing up to 60 days. There are four tests that conducted in this study; compressive strength, water absorption, acid resistance and porosity in concrete.

1.5 Significance of Research

The efficient used in this waste materials can prevent or helps in depletion of natural aggregates such as gravel and granite. Other than that, the usage of oil palm shell in the concrete can reduce the amount of abundant waste material and contribute toward a greener environment. Use of fly ash can reduce the use of landfill for dumping and creates a cleaner environment.

1.6 Layout of the Thesis

In this thesis, chapter one describes the introduction part that consists of the problem statement, the objective of the study, the scope of research and layout of the thesis. Summary of literature review of oil palm shell (OPS) lightweight aggregates concrete (LWAC) and fly ash (FA) is discussed in chapter two of the thesis. In the literature review, the utilization of oil palm shell is elaborate further in terms of the method to treat the oil palm shell based on the previous study. It also includes the description on each of the material used in the concrete such as fly ash, cement, sand, and superplasticizer.

Chapter three basically describe the methodology part of the research that consists of apparatus used, preparation of material and sample, the method used and laboratory test of a sample. Chapter four presents result and data on the durability properties of the oil palm shell (OPS) lightweight aggregates concrete (LWAC). Finally, chapter five concludes the whole research based on the objects that has been listed. Several recommendations are included for future research.

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