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DURABILITY PROPERTIES OF CONCRETE WITH OIL PALM SHELL (OPS) AGGREGATES

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Title : Durability Properties of Concrete with Oil Palm Shell (OPS) aggregates

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DURABILITY PROPERTIES OF CONCRETE WITH OIL PALM SHELL (OPS) AGGREGATES

COLLIN TIONG INN SENG

This project is submitted in partial fulfillment of
the requirements for the Degree of Bachelor of Engineering with
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To my beloved parents and cherished friends

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ABSTRAK

Perkembangan terbaru di bidang konkrit telah mengakibatkan pelbagai aspek yang perlu diambil kira bagi menghasilkan konkrit yang berkualiti tinggi dengan ciri yang lebih baik daripada konkrit biasa dan banyak memberi manfaat bagi kehidupan kita dalam jangka masa lama. Dalam indudtri pembinaan kini, pengunaan konkrit ringan juga semakin popular kerana isipadunya yang ringan dan ia mampu mengurangkan kos pembinaan bagi sesuatu projek. Kajian dilakukan bagi memenuhi keperluan industri pembinaan pada masa kini supaya sebuah bangunan yang ekonomi dapat didirikan. Kajian dilakukan bagi sisa tempurung kelapa sawit (OPS) telah dihasilkan dalam kuantiti yang banyak daripada industri pertanian di Malaysia. Penggunaan (OPS) ini sebagai agregat dalam konkrit dapat mengurangkan masalah pencemaran. Objektif daripada kajian ini adalah untuk menentukan sifat-sifat keawetan konkrit OPS dan membandingkan sifat keawetan antara konkrit OPS dengan konkrit normal. Ujian-ujian yang dilakukan keatas sample ialah kekuatan tegangan, jerapan air, "sorptivity" dan kekalisan konkrit. Kesumua sample yang disediakan melalui pengawetan air pada umur konkrit 3 hari, 7 hari, 28 hari dan 56 hari. Dimensi sample blok yang digunakan dalam kajian ini adalah 100mm x 100mm x 100mm, 150mm x 150mm x 150mm dan silinder adalah 100mm x 204mm. Hasilnya menunjukkan bahawa prestasi keawetan konkrit OPS menurun apabila peratusan penggantian OPS sebagai agregat kasar dalam campuran konkrit meningkat.

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LIST OF ABBREVIATIONS AND NOTATIONS

ABBREVIATIONS	FULL NAME
OPS	OIL PALM SHELL
SSD	SATURATED SURFACE DRY
GWT	GERMANN WATER PERMEATION TEST
CMS	CAHAYA MATA SARAWAK Sdn. Bhd.
i	Cumulative water absorption per unit area surface
S	Sorptivity coefficient
t	Time at which the weight is determined
K	Permeability coefficient (m/s),
c_c	Volume of water collected (m^3)
h	Height of specimen (m)
A	Area of specimen (m^2)
P	Pressure (m of water column)

CHAPTER 1

INTRODUCTION

1.1 Overview

Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. It is obtained by mixing cementitious materials, water and aggregates (and sometimes admixtures) in required proportions. The mixture when placed in forms and allowed to cure hardens into rock-like mass known as concrete (Beall et al, 2003).

The hardening is caused by chemical reaction between water and cement and it continues for a long time, and consequently the concrete grows stronger with age. The hardened concrete may also be considered as an artificial stone in which the voids of larger particles (coarse aggregate) are filled by the smaller particles (fine aggregate) and the voids of fine aggregate are filled with cement. In a concrete mix the cementitious

material and water form a paste called cement-water paste which in addition to filling the voids of fine aggregate, coats the surface of fine and coarse aggregates and bind them together as it cures, thereby cementing the particles of the aggregates together in a compact mass (Gambhir, 2004).

The major factors responsible for wide usage of concrete are mouldability, early hardening, and high early compressive strength. The concrete also have desired properties with admixture to be used in adverse situations, pumpability and durability. These are simple reasons for its extensive use in construction within a wide range by using appropriate ingredients and by special mechanical, physical and chemical processing techniques.

Based on the research of Mannan et al (2006), oil palm shell (OPS) concrete can potentially be utilized in lightweight concrete applications that require low to moderate strength such as pavements and infill panel for floorings and walls. OPS are light and naturally sized; therefore, they are ideal for substituting aggregates in lightweight concrete construction. OPS are agricultural solid waste which is biodegradable and can decay over a period of time if the environment is congenial, i.e. if enough moisture and sufficient air are present unless preservative treatment is done on the OPS aggregate.

Compared to normal weight concretes of 2400 kg/m^3, OPS concrete is approximately 20% lighter. This shows that OPS concrete would decrease 20% dead load when used in construction. By reducing the weight of the structure, the catastrophic

earthquake forces and inertia forces that influence the structures can also be reduced since these forces are proportional to the weight of the structure (Mannan et al, 2006).

1.2 Research Significance

In Malaysia since last two decades, the extensive building and infrastructure development projects have led to an increase in construction waste material generation. However, construction wastes which represent a greater proportion of total solid waste generation in the country and create greater problems such as illegal dumping should receive greater attention. On the other hand, the prices of construction materials increase from year to year due to the depletion of the natural resources. Therefore, the engineers do many researches and develop new materials relying on renewable resources. The resources include the use of by-product and the waste materials in building construction. It helps to reduce the pollution problems and improve the quality of environment.

Malaysia is well known for its palm oil industry and has become the world largest producer and exporter of palm oil. However, it is also the main contributor to the nation's pollution problem. The labors pick up the oil palm and send to the mill for process. After being processed, solid residues and liquid wastes are generated. These by-products include empty fruit bunches, fibre, shell, and effluent. According to Teo et al (2006), there are over 4 millions tones of OPS production per year in Malaysia and large amounts of waste OPS are left at the mill area.

Recently, the demand of low cost houses has increased and OPS can be used as the alternative for the normal aggregate to fulfill this demand. There are few examples with respect to this, Universiti Malaysia Sabah (UMS) had built a small footbridge of about 2 m in span in May 2001 and a low-cost house with a floor area of about 59 m^2 in 2003, both using OPS concrete and constructed near the coastal area within the campus (Teo et al, 2006).

Currently, research efforts have been directed towards the potential use of OPS as aggregate for the production of lightweight concrete. OPS is ideal as replacement of coarse aggregates replacement in concrete. The bulk density of OPS is much less than stone aggregate with a density of about 1850 kg/m^3. The compressive strengths of OPS concrete range from 20 to 24 N/mm^2 for 28 days; this satisfies the strength requirement of structural lightweight concrete (Mannan and Ganapathy, 2004).

From their research, concrete with OPS as coarse aggregate can be used for the construction of low-cost houses, farm structures, bus stop, wayside, pavements, blocks and paving drains. The most important concern for OPS concrete is the compressive strength and the durability characteristic because OPS as an organic aggregate may decay after a certain period.

1.3 Research objective

The specific objectives of this research are as follow:

1.) To investigate the compressive strength development of OPS concrete.

2.) To determine the durability performance of OPS concrete.

3.) To compare the durability performance between OPS concrete with normal concrete.

1.4 Scope of project

This project is classified as an experimental project. Several experimental works have been carried out to obtain the required data needed to accomplish this project. The research have been carried on define the durability of concrete with the OPS as replacement for coarse aggregates.

Firstly, laboratory test have been carried out to study the physical properties of both OPS and normal aggregates. For the aggregates, the laboratory tests will be carried out to determine the specific gravity, unit weight, total moisture content, surface moisture content, void ratio and absorption rate.

Secondly, the mix design and trial mix have been prepared to obtain the optimum mix proportion that achieves required design strength, workability and durability. Then, the control mixes have been prepared. After that, the coarse aggregates proportions of the control mix have been replaced by OPS in 25%, 50%, 75% and 100%.

For all the specimens, the target slump test for the concrete in this research is between 50mm to 75mm. The tests for the hardened concrete properties will be conducted at the specific age of 3 days, 7 days, 28 days and 56 days. All the information and results obtained from the tests will be used in order to carry out the objectives of the research.

1.5 Thesis Organization

This thesis is divided into five chapters.

i. Chapter 1 : Introduction

ii. Chapter 2 : Literature Review

iii. Chapter 3 : Methodology

iv. Chapter 4 : Result, Analysis and Discussion

v. Chapter 5: Conclusion and Recommendation

This thesis is divided into five chapters. Chapter one is mainly gives an introduction to the entire research project. It elaborates in general the definition of concrete, background of OPS concrete, objective and the scope of work in this project. Chapter two describes the literature review related to the study of OPS concrete and compares the OPS concrete with normal concrete.

Chapter three describes the methodology used to carry out this project. The details of methods use and laboratory works are also explained in this chapter. Chapter four presents the laboratory tests. The raw data have been analyzed and illustrated in table and graphical form. The discussions in this chapter regarding the results and problems faced in laboratory works. Finally, chapter 5 contains the summary, conclusions and also the recommendations from this research.