WATER ABSORPTION AND SORPTIVITY OF NORMAL STRENGTH OIL PALM SHELL CONCRETE

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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 Bachelor Degree of Civil Engineering

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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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ABSTRAK

Kelapa sawit telah ditemui mempunyai potensi untuk dijadikan bahan campuran dalam konkrit berdasarkan percubaan yang dilakukan oleh para penyelidik untuk mengetahui dengan lebih luas lagi tentang bahan buangan industri minyak kelapa sawit untuk digunakan dalam industri konkrit. Percubaan tersebut juga dilakukan dengan tujuan untuk mengurangkan jumlah bahan semula jadi daripada produksi konkrit dan untuk mengurangkan bahan buangan yang mencemarkan alam sekitar. Projek ini dilakukan adalah untuk mengetahui daya ketahanan konkrit kelapa sawit yang mempunyai daya ketahanan lasakkan konkrit mengandungi tempurung kelapa sawit yang berkekuatan normal. Kelapa sawit digunakan sebagai sebahagian bahan pengganti agregat kasar di dalam konkrit dengan peratusan yang berbeza iaitu 0%, 50% and 100% dan diuji dari segi ujian mampatan, ujian penyerapan air dan ujian *sorptivity*. *Fly ash* juga digunakan sebagai tambahan untuk bahan bersimen. Kesemua spesimen telah tertakluk kepada pengawetan air selama 7 dan 28 hari. Kekuatan untuk konkrit gantian 50% OPS (OPSC50) adalah lebih tinggi daripada konkrit gantian 100% (OPSC100). Selain itu, peratusan penyerapan air untuk OPSC50 adalah rendah daripada OPSC100 dan itu menunjukkan bahawa OPSC50 adalah lebih bagus daripada OPSC100. Walau bagaimanapun, *sorptivity* untuk OPSC50 adalah tinggi daripada OPSC100. Dapat disimpulkan bahawa kadar campuran konkrit yang betul dan yang mengandungi tempurung kelapa sawit, *fly ash*, air, *superplasticizer*, kerikil, pasir dan kandungan simen dapat menghasilkan konkrit kelapa sawit berkekuatan normal.

ABSTRACT

Oil palm shell (OPS) was found to have the potential to be used as a mixing ingredient in concrete based on the attempts made by researchers to explore the potential of the palm oil industry by-products to be used in concrete industry. The attempts also made with the aim to reduce the amount of natural resources from being harvested in concrete production and to decrease the amount of waste disposed to the environment. This study was conducted to observe the durability performance of normal strength oil palm shell concrete (OPSC).The OPS was used as a replacement of coarse aggregate with different percentages which are 0%, 50% and 100% in the concrete and it was being tested for compressive test, water absorption test and sorptivity test. Fly ash was also being used as an addition for cementitious material. All the specimens were subjected to water curing for 7 and 28 days. The strength of 50% OPS (OPSC50) replacement was higher than 100% OPS (OPSC100) replacement. Meanwhile, percentage of water absorption for OPSC50 was lower than OPSC100 and it indicates that OPSC50 is better than OPSC100. However, the sorptivity of OPSC50 is higher than OPSC100. It can be concluded the right concrete mix proportion of oil palm shell, fly ash, water, superplasticizer, gravel, sand and cement content would be able to produce normal strength oil palm shell concrete.

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LIST OF SYMBOLS

A	Cross-sectional area of the cube
A	Constant which takes into account effect of initial water filling at concrete surface
i	Cumulative volume of water absorbed
P	Maximum load at failure
s	Sorptivity coefficient
t	Time
Wd	Oven dry mass of specimen in air
Ws	Saturated surface dry mass of specimen in air (30 minutes and 72 hours)

LIST OF ABBREVIATIONS

C-S-H	Calcium silicate hydrate
EFB	Empty fruit bunch
LWC	Lightweight concrete
MOE	Modulus of elasticity
NWC	Normal weight concrete
OPC	Ordinary Portland cement
OPS	Oil palm shell
OPSC	Oil palm shell concrete
OPSC0	Oil palm shell concrete that contain 0% OPS
OPSC100	Oil palm shell concrete that contain 100% OPS
OPSC50	Oil palm shell concrete that contain 50% OPS
PKS	Palm kernel shell
POME	Palm oil mill effluent
w/b	Water/binder

CHAPTER 1

INTRODUCTION

1.1 Background of Study

By taking consideration of the environmental problems faced today, rapid depletion of conventional aggregates from by-products and solid waste materials from different industries are highly sensible. One of the alternatives is oil palm shell (OPS) (Teo et al., 2007). Oil palm shells are agricultural solid end products of oil palm manufacturing process. Palm trees grow in regions where the temperature is hot with abundant rainfall such as Malaysia, Indonesia and Thailand. Palm oil production is a remarkable industry in the Malaysian economy, as Malaysia is the world's second largest producer of the commodity in 2012 (Yew et al., 2014). Figure 1 shows a palm oil fruit bunches near Johor, Malaysia (Taylor, 2018).

Large amounts of by-products such as empty fruit bunches (EFB), palm kernel shells (PKS), oil palm shells (OPS) like in Figure 1.2 and palm oil mill effluent (POME) has been produced during the process of palm oil and that is a prevailing problem as the by-products are one of the main contributor to the nation's pollution problem. OPS are one of the wastes produced during palm oil processing. It has been reported that a large amount of OPS waste materials are stockpiled and dumped and that causes the storage problems within the vicinity of factories as large quantities of these waste are produced every day. In Malaysia, it is estimated that over 4 million tonnes of OPS is produced annually as waste. The availability of this waste has initiated the efforts to use this material in normal and high strength concrete (Yew et al., 2014).

Figure 1.1 Palm oil fruit bunches near Johor, Malaysia

Source: Taylor (2018)

Figure 1.2 OPS lightweight aggregate with fiber and without fiber

Source: (Shafigh et al., 2011)

The durability performance is an important aspect that determines the viability of OPS concrete to be used in practical applications. This is because OPS concrete will be affected by exposure to an environment and may deteriorate under this exposure during the service life of a concrete structure. The absorption characteristics of a concrete indicates its durability. An absorption test by full immersion of the specimens in water provides an indication of the open pore volume. Other than that, the

permeability of concrete has high bearing on the concrete durability as it controls the penetration rate of moisture that may contain harmful or aggressive chemicals (Teo et al., 2007). Next, laboratory test like sorptivity will also be conducted to know the durability performance of the concrete.

The compressive strength determines whether the concrete will be classified as normal or high strength concrete. The most used type is normal strength concrete in terms of application compared to high strength concrete. The main objective of using high strength concrete is to reduce the weight, permeability issues and to improve the durability of the structure. The mixed fresh concrete of normal and high strength concrete must be plastic or semi-fluid in nature as it can be moulded by hand or by using any tools. Uniform distribution of aggregates in the concrete helps in controlling the segregation. The workability factors determine from how ease the concrete is placed, compact and finished in its fresh state. Bleeding means the settlement of solid particles of the cement and the aggregate in the fresh concrete mix results in the development of a layer of water on the top of the concrete surface. There is no issue with small bleeding but large-scale bleeding will affect the durability and strength of the concrete. All the durability concerns will have a direct relationship with the permeability of the concrete (Zhang & Zong, 2014).

1.2 Problem Statement

Malaysia as one of the major palm oil producers in the world has been produced huge amount of waste such as oil palm shell and palm oil fuel ash from the palm oil mill. The disposal of this solid waste to the new landfills seems to be less economics for the palm oil mill management as it takes long to biodegrade and also less environmental friendly. The continuous dumping of these solid wastes would constitute more severe environmental problems in terms of land pollution.

There are many study of durability performance that have been conducted by using OPS as conventional material in concrete such as durability performance of OPS lightweight concrete for insulation building (Ekonomi et al., 2013) and, structural bond and durability properties of lightweight concrete made from OPS (Teo et al., 2007). There are not many study focus on durability performance of normal and high strength concrete by using OPS. Therefore, this research will be conducted to reveal about this.

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