PERFORMANCE OF LIGHTWEIGHT CONCRETE USING PALM OIL CLINKER AS COARSE AGGREGATE

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To my beloved husband,

Muhammad Nur Daud

To my lovely children,

Amir, Aqila and Aqil

To my beloved mother

Wan Roihanas Wan Ab Rahman

To my supervisor

Dr Roslli Noor Mohamed

And last but not least, to all my friends. Thank you for all of your opinions and supports, may Allah bless you.

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ABSTRACT

Malaysia is one of the primary producers of palm oil in Asia and it is the second largest palm oil-producing country in the world. Due to a lot of waste from palm oil mill and the construction costs are rising, the alternative to recycle them should be taken. In this study, palm oil clinker (POC) aggregates were used as coarse aggregate replacement in lightweight concrete production. This study focused mainly on the physical properties of POC aggregate and the performance of fresh and hardened concrete mixture to identify the optimum content of replacement of POC as coarse aggregate in lightweight concrete to attain reasonable strength. The approach used in the mix design involved POC replacement of 0%, 33%, 67% and 100% of the content of coarse aggregates. Based on sieve analysis, the coarse aggregate was well graded. It was found that, as the percentage of replacement of POC increased, the workability of the fresh concrete and density of hardened concrete was decreased. This was due to the physical properties of POC aggregate which is porous, low specific gravity, low bulk density and high water absorption. The maximum compressive strength of the sample was 25.24 MPa at 7 days and 27.89 MPa at 28 days while splitting tensile strength and flexural strength achieved 5.12 MPa and 3.98 MPa. As obtained from experiment, the optimum content of replacement of POC as coarse aggregate to achieve lightweight concrete was about 67% since the results from mechanical properties test complied with the requirement of structural lightweight concrete as stipulated in British Standard, BS 8110 : Part 2 : 1985, RILEM's functional classification of lightweight concrete, ASTM C330 and other previous studies. Considering POC into the lightweight concrete structure, it is possible to reduce the dead load thus saving the construction cost by reducing the size of columns, footings and other load bearing elements of a concrete structure.

ABSTRAK

Malaysia merupakan salah satu daripada pengeluar utama minyak sawit di Asia dan ia adalah negara pengeluar minyak sawit kedua terbesar di dunia. Oleh kerana banyak sisa dari kilang minyak sawit dan kos pembinaan yang semakin meningkat, alternatif untuk kitar semula perlu diambil. Dalam kajian ini, agregat daripada klinker minyak sawit (POC) telah digunakan untuk menggantikan agregat kasar dalam penghasilan konkrit ringan. Kajian ini menfokuskan kepada sifat-sifat fizikal agregat POC dan prestasi konkrit segar dan keras untuk mengenal pasti kandungan optimum penggantian POC sebagai agregat kasar dalam konkrit ringan untuk mencapai kekuatan yang munasabah. Pendekatan yang digunakan dalam reka bentuk campuran dalam penggantian POC adalah sebanyak 0%, 33%, 67% dan 100% daripada kandungan agregat kasar. Berdasarkan analisis ayak, agregat dikategorikan dalam penggredan yang baik. Didapati bahawa, semakin meningkat peratusan penggantian POC, kebolehkerjaan konkrit segar dan ketumpatan konkrit keras telah menurun. Ini disebabkan oleh sifat-sifat fizikal agregat POC yang berliang, graviti tentu yang rendah, ketumpatan pukal yang rendah dan penyerapan air yang tinggi. Kekuatan mampatan maksimum sampel adalah 25.24 MPa pada hari ke 7 dan 27.89 MPa pada hari ke 28 manakala kekuatan tegangan dan kekuatan lenturan mencapai 5.12 MPa dan 3.98 MPa. Kandungan optimum penggantian POC sebagai agregat kasar untuk mencapai konkrit ringan adalah kira-kira 67% di mana keputusan daripada ujian sifat mekanikal mematuhi keperluan struktur konkrit ringan seperti yang ditetapkan dalam Standard British, BS 8110: Part 2: 1985, klasifikasi konkrit ringan daripada RILEM, ASTM C330 dan kajian lain sebelumnya. Memandangkan penggantian POC diklasifikasikan sebagai struktur konkrit ringan, ianya boleh mengurangkan beban mati sekali gus menjimatkan kos pembinaan dengan mengurangkan saiz tiang, papak dan unsur-unsur galas beban lain bagi struktur konkrit.

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M	-	Margin
k	-	Value appropriate to the defect percentage permitted below the characteristic strength
s	-	Standard deviation
f_m	-	Target mean strength
f_c	-	Characteristic strength
W	-	Free water content
W_f	-	Free water content for uncrushed aggregate
W_c	-	Free water content for crushed aggregate
D	-	Density of fully-compacted concrete paste
C	-	Cement content
p	-	Density

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CHAPTER 1

INTRODUCTION

1.1 Background Of Study

The utilization of waste by-products in concrete has garnered positive outcomes over the past few decades in terms of the cost savings and conservation of natural resources (Kanadasan et al., 2015). The development of sustainability should be provided prudently due to the exponentially increasing population in the world and it implies that the degrading of natural resources rapidly might affect the future generation (Han, 2012). This has resulted in an increase in research to develop alternative feed to reduce and maintain a non-excessive usage of natural sources (Kanadasan et al., 2015). Therefore, researchers from the area of building and construction materials are trying to find an innovative solution to reduce the negative impact on the environment as well as to produce structural lightweight concrete. The idea is to use the solid waste from the agricultural and manufacture industries as coarse aggregate in lightweight aggregate concrete which will reduce the destruction of natural resources and demonstrate the proper management of solid waste (Nazmul et al., 2016).

1.5 Significance of Study

The significance of study and their performing analysis on replacement POC as coarse aggregate in concrete mix are :

i) The waste materials from palm oil mill can be used as replacement of coarse aggregate in order to reduce the cost for the construction industry
ii) By recycling and reuse of waste material, it can reduce the negative impact on the environmental
iii) Guidelines for researcher to study on characteristic of POC and their mechanical properties of fresh and hardened concrete mixture

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