THE APPLICATION OF OIL PALM FIBER ON CONCRETE STRUCTURE MATERIALS

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation)"

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

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DEDICATION

This research project is dedicated to my beloved family who are always there for me through my ups and downs in life.

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ABSTRACT

Oil palm fiber is one of the agricultural by-products from palm oil industry. If it is not treated properly, it may become solid waste in landfills. However, oil palm fiber is high in tension and low in density, hence many researches were conducted by scientists and engineers regarding the application of this fiber on the concrete structure material. In this project, oil palm fiber was applied to the concrete in order to produce the lightweight concretes and determine the optimum composition of this concrete. The ingredients of these oil palm fiber concretes are oil palm fiber, fly ash, sand, cement, and water. Thirteen types of concrete specimens with different percentage of ingredients were prepared. The effects of oil palm fiber as well as fly ash on the physical and mechanical properties of concrete were studied and evaluated through several testing. Density test and water absorption test were carried out by using a densimeter and some calculation. Dino Lite microscope was used to conduct the microstructural analysis, by observing and analyzing the microstructure of these concrete specimens. Furthermore, compression test and splitting tensile test were carried out by using an Instron Machine. Density, percentage of water absorption, microstructure, compressive strength and, splitting tensile strength were obtained from these testing. The data and results were tabulated in tables and analyzed by using graphs and charts. As a result, the optimum composition of oil palm fiber concrete was obtained with lower density, lower water absorptivity, good microstructure, and relatively higher compressive and splitting tensile strength. The optimum concrete specimen is D2 with the composition of 1 % oil palm fiber, 9 % fly ash, 40 % sand, 50 % cement, and extra 50 % water.

ABSTRAK

Serat kelapa sawit adalah salah satu produk sampingan dari industri minyak sawit. Jika serat kelapa sawit tidak diurus dengan tepat, ia akan menjadi sisa pepejal di tapak pelupusan. Walaubagaimanapun, serat kelapa sawit mempunyai ketegangan yang tinggi dan kepadatan yang rendah. Oleh itu, banyak kajian telah dijalankan oleh ahli sains and jurutera terhadap kesan-kesan penggunaan serat kelapa sawit dalam bahan struktur konkrit. Dalam projek ini, serat kelapa sawit telah digunakan untuk menghasilkan konkrit yang ringan, serta menentukan optimum komposisi pada konkrit ini. Serat kelapa sawit, abu terbang, pasir, simen, dan air merupakan bahan campuran untuk menghasilkan konkrit ini. Tiga belas jenis specimen konkrit dengan peratusan bahan yang berbeza telah disediakan. Kesan serat kelapa sawit dan abu terbang pada sifat-sifat fizikal dan mekanikal konkrit telah dikaji dan dinilai melalui beberapa ujian. Ujian ketumpatan dan ujian penyerapan air telah dijalankan dengan menggunakan Densimeter. Dino Lite mikroskop digunakan untuk menjalankan analisis mikrostruktur, dengan memerhati dan menganalisis mikrostruktur specimen konkrit. Tambahan pula, ujian mampatan dan ujian tegangan telah dijalankan dengan mengunakan Mesin Instron. Ketumpatan, peratusan penyerapan air, microsktruktur, kekuatan mampatan serta tegangan diperolehi daripada ujian-ujian tersebut. Data dan keputusan telah dijadualkan dan dianalisis dengan menggunakan graf-graf dan carta-carta. Pada kesimpulannya, komposisi konkrit gentian kelapa sawit yang paling optimum telah diperolehi dengan kepadatan yang rendah, penyerapan air yang rendah, mikrostruktur yang baik, kekuatan mampatan dan tegangan yang tinggi. Spesimen konkrit yang optimum adalah D2 dengan komposisi 1 % serat kelapa sawit, 9 % abu terbang,40 % pasir, 50 % simen, dan tambahan 50 % air.

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LIST OF ABBREVIATION

ACI	American Concrete Institute
ASTM	American Standard Testing of Materials
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimen in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C138	Standard Test Method for Density (unit weight), Yield, and Air Content of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic- Cement Concrete
ASTM C330	Standard specification for lightweight aggregates for structural concrete
ASTM C496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C567	Standard test method for determining the density of structural lightweight concrete
CaOH	Calcium Hydroxides
CCAA	Cement, Concrete and Aggregates Australia
CSH	Calcium silicate hydrate
FKM	Faculty of Mechanical Engineering
IS	Indian Standard
OPF	Oil Palm Fibre
OPFC	Oil Palm Fibre Concrete
OPS	Oil Palm Shell
OPTE	Oil Palm Trunk Fiber
SEM	Scanning Electron Microscope
UTeM	Universiti Teknikal Malaysia Melaka

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia is one of the largest palm oil producers and exporters in the world. According to Plantation Industries and Commodities minister Datuk Amar Douglas Uggah Embas, in the first quarter of the year 2014, Malaysia exported 1.3 million tonnes of palm oil and palm-based products valued at RM 3.5 mil to China (Tho, 2014). Although it contributes a lot in our country, however the oil palm industries produce abundant of oil palm by-products after palm oil extraction process. If these by-products handle improperly, they may become solid wastes and then dispose in landfills. Indirectly it is increasing the management cost for landfills as well as causing pollution to the environment.

The growing need for sustainable development has motivated scientists and engineers to make researches on the use of industrial by-products for other application. In recent years, certain of industrial by-product such as oil palm shell and fly ash have been used as construction materials. The oil palm shell (OPS) from palm oil industry has been used as aggregates in concrete. Besides that the fly ash from coal power plants has been used as mineral admixture in concrete (Mannan, 2002).

Many researches are also conducted by scientist and engineers to determine the effect of application of these industrial by-products on the physical and mechanical properties of concrete.

This lightweight concrete plays an important role in modern construction. Lightweight concrete offers design flexibility, less dead load, longer span, lower foundation cost. It is also reduce the transportation and placement cost due to the light-weight advantage. Moreover, it solves weight and durability problems in building, therefore many contractors, engineers, and architects started to use it in many construction purpose (Kenneth, 2014). Research regarding this type of concrete is still carried out by many scientist and engineer all over the world, in order to further improve the properties of this oil palm concrete for other advanced usage.

1.2 PROBLEM STATEMENT

Oil palm industry has contributed a lot in our country economy. However, it is also produces plenty of agricultural wastes during the extraction of palm oil in the palm oil mills, such as oil palm fibre and shell (Kim, 2010). If these oil palm by-products are treated improperly, it will become solid wastes in landfills or even disposed of through incineration and will pollute the environment. Recycle these oil palm fibre and use as aggregate in concrete can solve the problem of wasting and disposing of these agricultural by-product (Corinaldesi, 2011). Indirectly reduce the pollution to the environment and preferably reduce the cost of construction material. Therefore, the study of the application of oil palm fibre into the manufacturing of concrete should be carried out in order to produce an environmental friendly, low cost and lightweight oil palm fibre concrete.

1.3 OBJECTIVE

a) To apply oil palm fiber (OPF) and fly ash as the ingredients of concrete, in order to recycle and reduce these industrials by-products from becoming solid waste.

b) To determine the effect of OPF and fly ash on the physical and mechanical properties of concrete.

c) To determine an optimum composition of OPF concrete among the OPF concrete specimens.

1.4 SCOPE

This project will cover the application of oil palm fiber as aggregates and fly ash as additive in the oil palm fiber concrete. Besides that, the procedure in making of oil palm fiber concrete will be stated. Specimens with different percentage of composition of cement, sand, oil palm fiber, fly ash and water will be prepared. After that, density measurement, water absorption test, microstructural analysis, compression test, and splitting tensile test will be carried out to study the physical and mechanical properties of concrete specimens. In the end, an optimum composition of oil palm fiber concrete will be determined.

1.5 SIGNIFICANT OF STUDY

To study the application of oil palm fiber and fly ash on the concrete in order to produce a useful oil palm concrete as well as reducing industrials by-products. Procedure in making of concrete is studied as to prepare and obtain good concrete specimens for testing. Furthermore, the properties of oil palm fiber concrete are investigated by several testing accordance to American Standard Testing of Materials (ASTM) standard, in order to get a better testing result. Densimeter, Dino Lite miscroscope and Instron machine are used for conducting the tests. In the end, an optimum composition of oil palm fiber concrete is obtained.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION TO OIL PALM FIBER

Oil palm fiber is extracted from the oil palm tree. It is natural and bio-degradable, thus it is environmental friendly. Besides that, it is non-toxic and non-carcinogenic hence it is safe to use. Furthermore, it is low in moisture content and contains lignin that act as binder in compressed materials, thus it can be used for other purpose, for instance used as aggregates in concrete.

Oil palm fiber can be classified into oil palm trunk fiber (OPTF), empty fruit bunch (EFB) fiber, shredded EFB fiber and mesocarp fiber.

EFB fiber is extracted from oil palm's vascular bundles in the empty fruit bunch of palm tree. After the fresh fruit bunch has been processed for producing of palm oil, the remaining EFB is treated as by-product. However EFB fiber possesses high carbon and therefore, it is often recycled to make high porosity carbon and molecular sieve carbon for gas filtration propose (H. C. Trading, 2009).

Shredded fiber is produced by cutting the EFB fiber into smaller pieces and loose structure. Hence shredded fiber has height volume-weight ratio (H. C. Trading, 2009) compare to EFB fiber and this can enhance the bio-fuel characteristic. Shredded fiber possesses low chlorine content thus it is safe and had used as a sustainable bio-fuel resource to replace coal and petroleum.

Mesocarp fiber is an elongated cellulose fiber and shorter than shredded EFB fiber. After palm oil extraction, this fiber is separated from palm kernel nut by cyclone separator. In the market, it is used as mattress fiber or bio-mass material. This fiber can also be used as filler for reinforce composite.

Oil palm trunk fiber (OPTF) is also one of the palm fibers which possess high tensile strength, high density and high content of lignin as in Table 2.1. Thus, it is often used as concrete reinforcement to enhance the strength of conventional concrete. Based on an experimental research, by adding 1 % of OPTF into concrete, durability of the concrete is improved against sodium hydroxide (NaOH) and sodium chloride (NaCI) attack. In addition, by adding 3 % of OPTF, concrete has a good resistance against the attack of hydrochloric acid (Ahmad, 2010).

Table 2.1: Properties of Oil Palm Trunk Fiber.

Properties	**Values**
Bulk density	1100 kgm^{-3}
Tensile Strength	300 – 600 N/mm^2
Modulus of Elasticity	15-32 GPa
Lignin	23.02

(Source: Ahmad, (2010))

Oil palm shell (OPS) from the kernel nut is also one of the by-products after the palm oil extraction process. It possesses high calorific value, high grade solid, but low sulfur and ash contents. Furthermore, OPS is light, thus many researches had carried out the investigation on OPS in lightweight concrete application. A researches shown after 28 days curing process, the air-dry density of OPS concrete was about 20 % less dense or lightweight than conventional concrete (Basri, 1998).

In the conclusion, oil palm fiber and shell which are going to dispose should be recycled for sustainable development as well as cost-saving. In recent years, many researchers have studied regarding the application of oil palm fiber. They tried to apply it to replace those non-renewable sources of construction material.

2.2 INTRODUCTION TO CONCRETE

Concrete is a combination of cement, aggregates, admixture and water into a mix. Before dry and harden, it is fresh concrete, undergo hydration it become hardened concrete. Typical type of cement use in concrete is Portland cement. Coarse aggregate usually is stone aggregate or natural fibers, while fine aggregate usually is sand. Admixture acts as a binder for the concrete mix such as fly ash and silica fume. Furthermore, many materials are recycled and used as the ingredients of concrete, such as natural fibers from farm and fly ash from coal power plants.

Concrete is versatile, it has many functions and widely use in farm and other agriculture enterprises. This is because concrete is strong, fire-resistance, insect and rodent proof, decay resistant, highly storm resistant, wear resistant, waterproof. Besides that, maintenance cost for a concrete construction is low (Herren, 2010).

The strength and durability of concrete depend on many factors, such as: the composition and proportions of the materials, the water-cement ratio of fresh concrete, the strength and proportion of aggregates by size, the type of cement used, the uniformity of the mixture, and the method or process of the preparation of concrete.

The precision in mixing all the ingredients of concrete is important, because the proportions of ingredients will influence the properties of the concrete. For an accurate mixture, each particle of aggregates is covered with cement paste and bound to each other when cement paste dries and hardens. For a superior concrete, aggregates of different sizes should fit together to form a fairly solid mass. The aggregates must be clean and free of clay and silt. This is because the tiny sizes of clay and silt will influence the function of aggregate in concrete mix. Therefore, the sand use to make concrete is usually the washed sand that has been flushed with water and free of clay and silt (Herren, 2010).