

PROPERTIES OF SELF COMPACTING CONCRETE CONTAINING  
UNGROUND PALM OIL FUEL ASH AS PARTIAL SAND REPLACEMENT

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PROPERTIES OF SELF COMPACTING CONCRETE CONTAINING UNGROUND  
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To my Beloved Parents yousif and fattaema in recognition and love their sacrifices,  
patience and affection are beyond description

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## ABSTRACT

Since last few years replacement concrete materials with industrial by-products and agricultural wastes in concrete production are widely used. It imparts positive environmental effect because the waste materials are not released to the environment. Malaysia is well known as the main crude palm oil producer and exporter in the world. Million tons of agro wastes such as palm oil fuel ash (POFA) are being produced every year with no commercial return on it. Due to the pozzolanic behaviour possessed by POFA, it could be significant when the POFA is being recycled and used in production of concrete. This project report presents part of the on-going research project to study the effects of unground Palm Oil Fuel Ash (UPOFA) as a sand replacement (the size between 2.36 mm to 600  $\mu\text{m}$ ) on the properties of self-compacting concrete in terms of compressive, flexural, splitting tensile strength, workability, absorption and density. The testing takes two stages, the first stage depended on five different concrete mixes were prepared, the different amount from UPOFA as a sand replacement were used in each concrete mix. i) 0% UPOFA as control mix, ii) 25% UPOFA, iii) 35% UPOFA, iv) 45% UPOFA, v) 100% UPOFA. The result indicates that a 25% replacement gave better workability and strength at curing periods at (7, 28, 56, 90) days. The 25% mix was then selected to produce SCC by different tests as Slump flow, V-funnel flow and L-box test. All specimens were cured in water and the tests were carried out at different ages within the allowable limit provided by BS1881:1983.

## ABSTRAK

beberapa tahun kebelakangan ini, penggantian bahan-bahan konkrit dengan sisa-sisa industri dan pertanian dalam penghasilan konkrit digunakan dengan meluas. Ia memberi kesan positif kepada alam sekitar kerana bahan-bahan sisa tidak dilepaskan ke alam sekitar. Malaysia terkenal sebagai pengeluar dan pengeksport minyak sawit mentah utama di dunia. Berjuta tan sisa pertanian seperti abu terbang kelapa sawit (POFA) dihasilkan setiap tahun tetapi tiada pulangan komersil daripada sisa ini. Disebabkan sifat pozzolanik POFA ini, adalah signifikan jika POFA ini dikitar semula dan digunakan untuk penghasilan konkrit. Laporan projek ini membentangkan sebahagian projek penyelidikan yang mengkaji kesan POFA kasar/mentah (UPOFA) sebagai bahan pengganti pasir (saiz antara 2.36mm hingga 600  $\mu\text{m}$ ) ke atas sifat-sifat sifat-sifat mampatan sendiri konkrit dari segi mampatan, lenturan, kekuatan tegangan pemisahan, keboleherjaan, penyerapan dan ketumpatan. Pengujian melibatkan dua peringkat, peringkat pertama melibatkan penyediaan lima adunan konkrit berlainan, jumlah UPOFA yang berbeza sebagai pengganti pasir yang digunakan bagi setiap adunan konkrit, i)0% UPOFA sebagai adunan kawalan ii)25%-UPOFA iii)35%-UPOFA iv)45% - UPOFA v)100% UPOFA. Keputusan menunjukkan penggantian menggunakan 25%-UPOFA memberikan tahap keboleherjaan dan kekuatan yang lebih baik pada tempoh perapian pada (7, 28, 56, 90) hari. Adunan 25% itu kemudian dipilih untuk menghasilkan SCC dengan ujian-ujian berbeza seperti ujian konkrit basah (slump test), Aliran Corong V, dan ujian kotak L. Semua spesimen telah dirapikan di dalam air dan ujian-ujian tersebut dijalankan pada tempoh masa yang dibenarkan sepertimana yang ditetapkan oleh BS1881:1983.

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**LIST OF ABBREVIATIONS/SYMBOLS**

FAS	.	Fine Aggregate Sand
UPOFA	.	Unground Palm Oil Fuel Ash
RMC	.	Ready-Mix Concrete
DEM	.	Discrete Element Method
fcu	.	Compressive Strength,
SCC	.	Sel-Compacting Concrete f
OPC	.	Ordinary Portland Cemente
APS	.	Average Particle Size
G <sub>ma</sub>	.	Apparent specific gravity
SSD	.	Saturated-surface-dry
G <sub>mb</sub>	.	Bulk specifc gravity of compacted mix
G <sub>sb</sub>	.	Combined bulk specific gravity of total aggregate
W <sub>p</sub>	.	Weight of empty clean and dry pycnometer
W <sub>ps</sub>	.	Weight of the pycnometer containing the dry UPOFA
WB	.	Weight of the pycnometer and contains
WA	.	Weight of pycometer and distilled water
W <sub>0</sub>	.	Weight of sample of oven-dry UPOFA
F.A	.	Fine Aggregate
C.A	.	Coarse Aggregate
SP	.	Chemical Admixture
UPV	.	Ultrasonic Pulse Velocity Test

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# CHAPTER 1

## INTRODUCTION

### 1.1. General

Concrete is one of the most important materials which are used mainly in construction, it must environment friendly construction materials with offer stability and flexibility in designing all building structures. The cost of concrete is relatively high due to the manufacturing cost of its main components and the fine aggregate sand (FAS). In addition to that, reports showed that from 1940 to 2001 the world's annual consumption of sand rose from 200 million tons to 2.74 billion tons [1]. Natural sand is mainly excavated from river beds or crush stone this was associated with major environmental costs. Therefore, there is a need to find other alternative materials to replace the aggregate sand. One promising fine aggregate material which has good properties is the unground palm oil fuel ash. Palm oil industry is one of the most important agro industries in Malaysia. A large amount of solid waste is output from the palm oil industry near to two million ton of solid waste of palm oil residue.

The gradient is effect on distribution of the pores and their diameters. That affect on the compressive and tensile strength because the pores are weakened to concrete's structure and also effect on the durability (increase the pores lead to decrease the durability), because it's consider as the entrances to the attack happened through it.



On the other hand, concrete is face major problem associated with low tensile strength compared to compressive strength. Because of that, many new technologies of concrete and some modern concrete specifications approach were introduced. There have been many experimental works was conducted by introducing a new material or recycled material as a replacement to aggregate or cement in concrete.

Currently, attention focus on sustainable term is related to the environmental and energy issues included global warming, greenhouse effect, pollutions, run out of natural resources and disturbance of ecosystems. Malaysia is also not left behind about this issue by encouraging industries in doing research to produce green products or technologies in order to satisfy needs of sustainable development.

Green Technology is the development and application of products, equipment and systems used to conserve the natural environment and resources, which minimize and reduces the negative impact of human activities. The basic principle of green technology is the green products have to minimize the degradation of the environment, has no or low greenhouse gas emission, safe for use and promotes healthy and improved environment for all forms of life, conserves the use of energy and natural resources and also promotes the use of renewable resources.

## **1.2. Problem Statement**

A large amount of solid waste is output from the palm oil industry near to two million ton of solid waste of palm oil residue. This is increasing environmental pressure but With increased environmental awareness and its potential hazardous effects, utilization of these materials has become an attractive alternative to disposal so the large volumes of this material need to be handled economically and in a way that reduces the impact on the surrounding environment.

There are many investigations on this material in various fields; the construction is one of these fields. Have been used in the production of concrete in order to improve the properties as the strength and the workability and also to improve the durability by provide the protection against the chemical and physical attack.

The most of the investigation focused on the cement replacement to improve the properties of concrete by utilize finer size (45m $\mu$  or less). The problems that occur with palm oil fuel ash disposal process are limited availability and very costly since large volumes of ground palm oil fuel ash is generated.

### **1.3. Scope of study**

The scope of study focuses on the changes on the properties of concrete by using the different percentages of unground palm oil fuel ash (UPOFA) as partial sand replacement with sizes between (600 m $\mu$  to 2.36 mm).

### **1.4. Objectives**

1. To evaluate the use of unground palm oil fuel ash (solid residues waste) as sand replacement material.
2. To produce performance data relating the effects of UPOFA amount on mechanical properties and durability of concrete.

- To determine the optimum UPOFA replacement levels to achieve a comparable strength to the control mix.
- To evaluate the fresh concrete properties i.e. slump, setting time.
- To evaluate hardens concrete properties i.e. density, absorption.
- To investigate the performance of Self-Compacting Concrete (SCC) containing optimum UPOFA.

### **1.5. Significant of Study**

Concrete is one of more materials was used widely in the world where plays an important role in the construction. Millions tons of concrete are used per year in various type of construction. Also millions tons were produced per year (near two million) from unground palm oil fuel ash(UPFOA) as a waste materials, So we can use unground palm oil fuel ash as pozzalanic materials because it's content silica as high percentage. That will help to improve the properties of concrete.

Also to dispose of waste by useful and economically way that due to the beneficial use of these materials with increasing environmental pressure to reduce waste and pollution and to recycle as much as possible. The concrete industry has begun adopting a number of methods to achieve these goals.

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