THE EFFECT OF NANO POFA AND NANO EGGSHELL POWDER TO HARDENED CONCRETE PROPETIES

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SUPERVISOR'S DECLARATION

I hereby declare that 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 degree of B. Eng (Honse) Civil Engineering

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STUDENT'S DECLARATION

I declare that this project report entitled 'THE EFFECT OF NANO POFA AND NANO EGGSHELL POWDER TO HARDENED CONCRETE PROPETIES' is the result of my own research for quotations and summaries. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Malaysia is one of the main crude palm oil producer and exporter in the world. Meanwhile, a million tonnes of agro wastes such as palm oil fuel ash (POFA) and eggshell (ESP) is being produced every year and it causes a problem in disposing of POFA and ESP. However, POFA and ESP have the high potential to be used as recycling construction materials in the production of concrete as it contains a high content of silica and calcium which possesses pozzolanic behaviour. For strength activity index of POFA and ES. Pozzolanic materials in concrete works are increasing, and are expected to continuously increase in the years ahead because of technological advancement and the desire for sustainable development. Concrete containing raw material is introduced to reduce the cost of the construction project by reducing the use of materials and formworks. Nano palm oil fuel ash and Nano eggshell powder has been treated and can be used as a partial replacement for cement in concrete due to its pozzolanic effect. The main purposes of this study are to investigate the effect of Nano POFA on concrete properties replacement as cement also to investigate the effect of Nano POFA with NESP on concrete properties replacement as cement improving the strength of concrete. There are six mixtures of concrete were prepared such as 0% of NPOFA and NESP as a control sample, 10%, 20%, 30% as NPOFA replacements and 2.5%, 5% as NESP replacements of cement. All the mix of fresh concrete specimen were casted into the cube (100x100x100). All specimens were tested to determine the compressive strength, UPV, Crbonation and Water absorption of concrete. All Specimens containing NPOFA and NESP were prepared at constant water-cement ratios of 0.5 with superplasticizer content of 1% with cement. The water absorption, UPV and compressive strength has been determined by the laboratory result where 20% of Nano POFA with 0% of Nano ESP replacement has the lowest water absorb, highest velocity of UPV and compressive strength compare to others so 20% of Nano POFA replacement is the optimum percentage as partial cement replacement. This optimum percentage conclude that the mix design is economical and friendly environmental to construction industry. The Study discovered that the compressive strength increased with NPOFA and NESP replacement up to 30% and 5% consequently the general optimum strength for all variable hardening tests was found at 30% of NPOFA and 5% of NESP replacement. In this study the objectives of this project is achieved because this project success to demonstrate Nano POFA and Nano ESP being a waste material, can be a good pozzolanic material on account of its higher silica and calcium content especially when its subjected to further treatment.

ABSTRAK

Malaysia adalah salah satu pengeluar minyak sawit mentah dan pengeksport utama di dunia. Sementara itu, satu juta tan sisa agro seperti abu minyak sawit (POFA) dan kulit telur (ESP) dihasilkan setiap tahun dan menyebabkan masalah membuang POFA dan ESP. Walau bagaimanapun, POFA dan ESP mempunyai potensi tinggi untuk digunakan sebagai bahan binaan kitar semula dalam pengeluaran konkrit kerana ia mengandungi kandungan silika dan kalsium yang tinggi yang mempunyai perilaku pozzolanic. Untuk indeks aktiviti kekuatan POFA dan ES. Bahan-bahan Pozzolanic dalam kerja-kerja konkrit semakin meningkat, dan dijangka terus meningkat dalam tahun-tahun mendatang kerana kemajuan teknologi dan keinginan untuk pembangunan mampan. Bahan mentah yang mengandungi konkrit diperkenalkan untuk mengurangkan kos projek pembinaan dengan mengurangkan penggunaan bahan dan formwork. Serbuk nano minyak kelapa sawit nano dan bubuk telur Nano telah dirawat dan boleh digunakan sebagai pengganti sebahagian untuk simen dalam konkrit disebabkan oleh kesan pozzolanicnya. Tujuan utama kajian ini adalah untuk mengkaji kesan Nano POFA terhadap penggantian sifat konkrit sebagai simen juga untuk mengkaji kesan Nano POFA dengan NESP pada penggantian sifat konkrit sebagai simen meningkatkan kekuatan konkrit. Terdapat enam campuran konkrit yang disediakan seperti 0% NPOFA dan NESP sebagai sampel kawalan, 10%, 20%, 30% sebagai penggantian NPOFA dan 2.5%, 5% sebagai pengganti NESP simen. Semua campuran spesimen konkrit yang baru telah dimasukkan ke dalam kiub (100x100x100). Semua spesimen telah diuji untuk menentukan kekuatan mampatan, UPV dan penyerapan air konkrit. Semua spesimen yang mengandungi NPOFA dan NESP disediakan pada nisbah simen air tetap sebanyak 0.5 dengan kandungan superplasticizer sebanyak 1% dengan simen. Penyerapan air, UPV dan kekuatan mampatan telah ditentukan oleh hasil makmal di mana 20% daripada Nano POFA dengan 0% penggantian Nano ESP mempunyai penyerapan air yang paling rendah, halaju tertinggi UPV dan kekuatan mampatan berbanding dengan yang lain sehingga 20% daripada Nano POFA Penggantian adalah peratusan optimum sebagai pengganti simen separa. Peratusan optimum ini menyimpulkan bahawa reka bentuk campuran adalah ekonomi dan mesra alam kepada industri pembinaan. Kajian mendapati bahawa kekuatan mampatan bertambah dengan NPOFA dan penggantian NESP sehingga 30% dan 5% akibatnya kekuatan optimum umum untuk semua ujian pemboleh ubah berubah didapati pada 30% NPOFA dan 5% penggantian NESP. Dalam kajian ini matlamat projek ini dicapai kerana kejayaan projek ini untuk menunjukkan Nano POFA dan Nano ESP menjadi bahan buangan, boleh menjadi bahan pozzolanik yang baik berdasarkan kandungan silika dan kalsiumnya yang lebih tinggi terutama apabila ia mengalami rawatan lanjut.

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LIST OF ABBREVIATIONS

PSBE	Processed Spent Bleaching Powder
FC	Foamed Concrete
LFC	Lightweight foamed concrete
OPC	Ordinary Portland Cement
ASTM	American Society for Testing and Materials
FKASA	Fakulti Kejuruteraan Awam dan Sumber Alam
UTM	Universal Testing Machine
UMP	Universiti Malaysia Pahang
US	United State
w/c	Water-Cement ratio
s/c	Sand-Cement ratio
MgO	Magnesium Oxide
SO_3	Sulphur Trioxide
CO_2	Carbon Dioxide
CH	Calcium Hydroxide
CSH	Calcium Silicate Hydrate
C_3S	Tricalcium Silicate
CaO	Calcium Oxide
Kg/m^3	Kilogram per meter cube
Mpa	Mega Pascal
km/s	UPV value
L	Length
mm	Milimeter
h	Hour
cm^2/g	Centimeter square per gram
kN	kilo Newton
kN/s	kilo Newton per second
kPa	kilo Pascal
^oC	Degree Celcius
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Concrete is one of the composite construction material that composed primarily of aggregate, water and cement. It has been used widely in the field of construction for making various structures such as architectural structures, foundations, pavements, bridges and so forth. Therefore, the various concrete types available nowadays are attributed to the continuous research and development of concrete over the years to provide more alternative construction material for making construction structure. However, the popularly utilise of lightweight concrete, also known as aerated concrete in the European countries construction field due to its versatilities and lightness, which has brought an offer application of new alternative building material for the improvement of Malaysia building technology. The classification of concrete type is mainly depending on the concrete density. By using the lightweight concrete which possesses low density properties, it is capable of contributing towards the reduction of building dead load and resulting in more economic structural design (Short and Kinniburgh, 1978; Narayanan and Ramamurthy, 2000b) as reduction of dead load may consequently the reduction of size of bearing load structure. The practical range of concrete density for lightweight concrete is between 300 kg/m^3 and 1850 kg/m^3 (Neville, 2006). Besides that, other than lightweight concrete possess the advantage of low density properties, it is also good in fire resistance and thermal insulation properties. Throughout the world, concrete is being widely used for the construction of most of the buildings, bridges and others. Hence, it has been properly labelled as the backbone to the infrastructure development of a nation. Nowadays, the construction industries are searching for alternative products that can reduce the construction cost.

Various types of waste material with processing and treatment might be replaced as a potential building material and to be used in many types of construction project. However, not all the waste material can be reuse as building materials even to process it as well. Thus, researches and experiment to evaluate the effective and potential of waste reuse for construction industry is required. The usage of waste product such as Eggshell powder (ESP) and palm oil fuel ash (POFA) as cement replacement to produce a new upgraded concrete are seen to be the most effective way to maximize the profit while reducing the amount of waste. To support this research we will used Nano size to investigate the effect of Nano POFA on concrete properties. Also to investigate the effect of Nano POFA with Nano Eggshell on concrete properties.

Egg shells are agricultural throw away objects produced from chick hatcheries, bakeries, fast food restaurants etc. which can damage the surroundings and as a result comprising ecological issues/contamination which would need appropriate treatment. Egg shell also creates some allergies when kept for longer time in garbage. Use of egg shell waste instead of natural lime to replace cement in concrete can have benefits like minimizing use of cement, conserving natural lime and utilizing waste material. Eggshells are known to have good strength characteristics when mixed with concrete. Calcium rich eggshell is a poultry waste with chemical composition nearly same with the limestone (Amu et al., 2005). Besides, its chemical composition almost similar to that of ordinary Portland cements (Uma Shankar & Balajl, 2014). However, as limestone is a natural mineral resource, quarrying and further uses of limestone may lead to problems related to environment. A part from that, lime production involves energy intensive process and consumes water. Therefore, identifying analogous material from waste and using the same in concrete production could be wise idea. Use of eggshell waste instead of natural lime to replace cement in concrete brick can have benefits such as reducing the use of cement. The use of eggshell powder in concrete production reduced the cost of raw material and contributes to the construction industry. Thus, eggshells can be applicable to reduced cost of construction material and produced a new raw material for development in the construction industry. Eggshell consists of several mutually growing layers of calcium carbonate $CaCO_3$, magnesium carbonate $MgCO_3$ and protein. The innermost layer-maxillary 3 layer grows on the outermost egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer covered by the organic cuticle (Gowsika, Sarankokila, & Sargunan, 2014). The

eggshell primarily contains calcium, magnesium carbonate (lime) and protein. In many other countries, it is the accepted practice for eggshell to be dried and use as a source of calcium in animal feeds. The quality of lime in eggshell waste is influenced greatly by the extent of exposure to sunlight, raw water and harsh weather conditions. It is the fine grained powder with suitable proportion which is sieved to the required size before use with concrete/mortar.

The oil palm is a tall-stemmed tree which belongs to palm family Palmea. The countries in the equatorial belt that cultivate oil palm are Benin Republic, Colombia, Ecuador, Nigeria, Zaire, Malaysia and Indonesia of which Malaysia is the largest producer of palm oil and palm oil products. It has been estimated that the total solid waste generated by this industry in some two hundred palm oil mills in the country has amounted to about ten million tons a year. These by-products are commonly used as fuel in the boiler of palm oil mills and become ash. This ash is simply disposed of without any commercial return. The ash, popularly known as palm oil fuel ash or POFA is a waste material the disposal of which poses enormous environmental pollution. On the other hand, the continuous research of producing a new concrete material of palm oil fuel ash (POFA) was developed. Malaysia is a country with full of resources and it was being the largest producer and exporter of palm oil in the world, accounting for 52% of the total world oil and fats exports in year 2006 (Sumathi, Chai, & Mohamed, 2008). Hence, it has led to higher volume of palm oil mill by-product such as POFA generated and being dumped in the landfill. In this scenario, it is predicted that larger amount of POFA will be discarded as environmental polluting waste in future. Therefore, POFA had been chosen in research as new concrete material to process this material for other applications in order to convert the environmentally polluting by-product problem into beneficial for the development of human civilization. In addition, success in producing palm oil fuel ash based aerated concrete not only could reduce the quantity of ashes as environmental waste but also introduce new agro based aerated concrete which is adequate for the use in tropical countries. Malaysia, Indonesia and Thailand are the main palm oil producer and exporter in the world, which is a leading agricultural cash crop in these tropical countries. Malaysia is concentrating on bio-technology industry and its objective is to produce better and quality agriculture products. In addition, palm oil is listed as one of the main commodities to be exported internationally and consequently it will being generate bigger amount of palm oil fuel ash and being dumped in the landfill. (POFA) is

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