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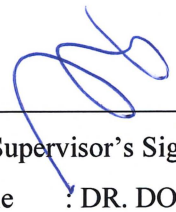
I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering (Hons) Civil Engineering



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STUDENT'S DECLARATION

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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THE MECHANICAL PROPERTIES OF BLENDED CEMENT USING MICROWAVED SEWAGE SLUDGE (MSSA) AND EGGSHELL POWDER (ESP)

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ABSTRACT

The rapid growth of the population in the developing country leads to the increment of the production of the wastes. Besides that, it is also leads to prosper of construction industry due to the high demand of houses and buildings. Hence, construction materials such as cement are highly demand in construction industry. Huge amount of sewage sludge and eggshells being produced from year to year and need to be disposed with proper waste management. Current disposal method for both wastes through landfill caused Malaysia facing the waste management problem as we are running out of landfill site. An alternative method to dispose sewage sludge and eggshell is to utilize it as one of the construction material. The study of the possibility to turn waste into suitable construction materials in concrete production is carried out. The sewage sludge and eggshell waste are treated and used as blended cement to partially replace the cement. In this research, four different percentage of eggshell powder with 10% of microwaved sewage sludge ash (MSSA) were replaced with the cement in concrete production and tested by slump test, compressive strength test, flexural strength test and splitting tensile strength test. From the investigation, the results of 10% MSSA partial cement replacement with different percentage of eggshell powder has shown the increment in strength and has the potential to replace cement since the concrete strength with the blended cement are higher than the normal plain concrete.

ABSTRAK

Pertumbuhan pesat penduduk di negara-negara membangun membawa kepada kenaikan pengeluaran bahan buangan. Selain itu, ia juga membawa kepada peningkatan dalam industry pembinaan kerana permintaan yang tinggi terhadap pembinaan rumah-rumah dan bangunan. Oleh itu, bahan binaan seperti simen sangat diperlukan. Sejumlah besar sisa kumbahan dan kulit telur yang dihasilkan dari tahun ke tahun perlu dilupuskan dengan pengurusan sisa yang betul. Kaedah pelupusan semasa untuk kedua-dua bahan buangan melalui tapak pelupusan menyebabkan negara kita menghadapi masalah dalam pengurusan sisa kerana kehabisan tapak pelupusan. Kaedah alternative untuk melupuskan sisa kumbahan dan kulit telur adalah menggunakan ia sebagai salah sastu bahan pembinaan. Kajian telah dijalankan untuk menguji kesesuaian kedua-dua bahan buangan untuk dijadikan sebagai bahan binaan untuk menggantikan sebahagian daripada kuantiti simen. Dalam kajian ini, empat peratusan yang berbeza untuk serbuk kulit telur dan mikro abu sisa kumbahan telah digantikan dengan simen dalam penghasilan konkrit dan diuji oleh ujian turunan, kekuatan mampatan, kekuatan lenturan dan kekuatan tegangan berpecah. Daripada penyiasatan itu, keputusan 10% mikro abu sisa kumbahan dengan peratusan yang berbeza untuk serbuk kulit telur telah menunjukkan peningkatan dalam kekuatan dan mempunyai potensi untuk menggantikan simen kerana kekuatan konkrit dengan kedua-dua sisa bahan buangan ini adalah lebih tinggi daripada kekuatan konkrit biasa.

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LIST OF SYMBOLS

%	Percentage
mm	Millimeter
N/mm^2	Newton per millimeter square
kg	Kilogram
N	Newton
kN	Kilonewton
kg/m^3	Kilogram per meter cubic
w/c	Water to cement ratio
mm^2	Millimeter square
m	Meter cubic
Pa	Pascal
MPa	Mega Pascal
°C	Degree Celsius
µm	Micrometer
±	Plus-Minus

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
ESP	Eggshell Powder
MSSA	Microwaved Sewage Sludge Ash
OPC	Ordinary Portland Cement

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Waste products are an unusable or unwanted substance or material produced from a manufacturing process or from community and household activities that seriously pollute our environment. Pollution becomes one of the major environment issues in Malaysia that cause harm or discomfort to humans or other living organisms. Regardless of huge amount and complexity nature of waste created, the waste management in Malaysia is still poor. To support the sustainable development in our country, waste should be recycled, reused, and provide for the needs of future generations of life on the planet. This can help to reduce the amount of wastage in Malaysia and protect the environment.

Nowadays, waste products such as oil palm shell, sludge and fly ash are used in the industry of construction to improve the quality of building materials instead of reduce the amount of the waste. Eggshells are known as natural solid waste and commonly disposed in the landfills without pretreatment. The use of eggshells in the construction industry as building materials reduced amount of waste and improve the quality of environment.

Through some of research found that the present of Calcium Carbonate ($CaCO_3$) in eggshell can increase hardness and strength to the concrete. Approximately 94% of a dry eggshell is calcium carbonate and has a typical mass of 5.5 grams. The chemical composition (by weight) of by product eggshell has been reported as follows: calcium carbonate (94%), magnesium carbonate (1%), calcium phosphate (1%) and organic matter (4%) (Stadelman, 2000). The use of such by products in concrete construction

not only prevents these products from being land-filled but also enhances the properties of concrete in the fresh and hardened states (Karthick, 2014).

Otherwise, Malaysia also facing major challenge in wastewater plants to dispose the left over of sludge from treating sewage water. As the population of human increase from year to year, the more wastewater effluents are collected either from housing area, hospital or industrial establishment. Sewage waste can cause the pollution of the environment since nowadays there is limited landfill sites existing for the disposal process. Besides that, due to the strict environmental regulations for the disposal options, studies show that the volume of sewage sludge is expected to increase.

There are some alternative had been figure out where large amount of sludge are used in agriculture field as composts. But later on, there is problem came from the existence of toxic materials in some sludge types which makes them unsuitable. As the pollution of the environment become worst, the parties concern trigger out some alternative disposal routes encountering and exploring new fields of sludge disposal.

There are researchers carry out the studies of the properties of sewage sludge and attempted reuse and recycle waste to enhance a sustainable environment. The resulting sewage sludge ash (SSA) obtained can be placed in controls landfills or used in construction to improve certain properties of building materials (Cenni et al., 2001) where the dry sludge is used as replacement material to concrete mixes. Reuse or recycling such waste to develop sustainable construction materials as proved to be a practical solution to disposal and environmental problem. Production of concrete is possible by using recycled materials from waste to replace some of the traditional mixture components in concrete products and produce a more sustainable building material (Raji et al., 2015).

1.2 PROBLEM STATEMENT

The highest waste production is from food or organic waste as the main waste component with 32%, follow by paper and plastic with composition of 21% and 14% respectively (Pariatamby, 2005). Besides that, Jackie (2009) also reported that the

world's egg companies process an estimated one million eggs which generate huge volumes of wastes every day.

All over the world, eggshells mostly generated from chicken hatcheries, bakeries and restaurants. Offensive undesirable smell from the eggshells contributes to the level of air pollution when large amount of eggshells had been generated especially around the residential area and the factories. The citizens may suffer from out of breath because need to withstand with this problem every single day. Besides that, it is also can lead to increase of the risk of health problem to the public since it may attract pest such as rats or insects due to the organic protein matrix. Furthermore nowadays there is bacterial infection called Leptosprirosis that is carried by animals, most commonly in rats which can lead to death. Therefore, extract the eggshells into useful product can bring benefits especially to guaranteed the human health and in construction industry where eggshell can be used as an additive in concrete that bound in strength properties.

On the other hand, Urban Wellbeing, Housing and Local Government Minister Datuk Abdul Rahman Dahlan also stated that Bukit Tagar landfill at Selangor is still around but in another 100 years this whole area will be developed as an urban area and we are running out of space and time to improve the disposal method of wastes. Although the amount of these may not 100% support in the concrete industry but it could be treated as partial replacements (Pliya and Cree, 2015).

Besides that, sewage plant industry also facing the same wastage problem as volume of sludge keeps increasing in Malaysia. Siti (2013) has predicted that 7 million metric tons of sewage sludge will be generated annually in 2020 with the cost of management up to US$ 0.33 billion per year. Without a solid transfer technique for the sludge the real concept of water protection will fall flat. These may bring harm to the public health where the existences of sludge lead to the spreading of diseases because of wastewater.

There are four types of pathogens which are bacteria, protozoa, viruses and helminthes that can make human sick. Besides that, it is also contribute to environmental pollution when dumping the waste in open fields especially the unpleasant smell from the waste make the resident uncomfortable. The sewage sludge

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