THE PERFORMANCE OF CONCRETE USING FLYASH AND BOTTOASH AS PARTIALLY REPLACEMENTOF CEMENT AND FINE AGGREGATE

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SUPERVISOR'S DECLARATION

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 Bachelor Degree of 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.

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ABSTRAK

Koncrete adalah salah satu bahan binaan tertua yang digunakan dalam pembinaan pelbagai struktur di seluruh dunia. Oleh kerana permintaan yang tinggi, bahan yang digunakan untuk pengeluaran konkrit berkurang setiap tahun. Pada masa kini, permintaan untuk pasir simen dan kerikil terus meningkat dalam pengeluaran konkrit. Perlombongan pasir yang berlebihan akan mengakibatkan kemusnahan persekitaran sungai. Perlombongan pasir yang tidak disengajakan dan menyalahi undang-undang telah mewujudkan banyak masalah dalam persekitaran alam sekitar dan kualiti air di lembangan sungai. Dalam kajian ini, sisa loji kuasa tempatan digunakan sebagai pengganti simen dan agregat halus. Penyiasatan ini dijalankan untuk menyiasat prestasi konkrit menggunakan abu terbang dan bawah. Terdapat 3 jenis campuran Digunakan dalam kajian ini dan peratusan abu terbang ditetapkan pada 25% dan abu bawah adalah antara 0%, 5%, dan 10%. Tahap gantian simen dan halus agregat telah dilemparkan sebelum tertakluk kepada air menyembuhkan selama 7, dan 28 hari. Ujian kemusnahan, ujian kekuatan mampatan, dan kekuatan lenturan telah dijalankan mengikut piawaian yang sedia ada. Nilai kemerosotan menurun dengan peningkatan tahap penggantian pasir dengan abu bawah. Peratusan penyerapan air konkrit bertambah dengan peningkatan paras penggantian pasir dengan abu bawah. Secara mendalam. Selain itu, konkrit dengan 10% penggantian agregat kasar mencapai kekuatan mampatan tinggi iaitu 34.436 N / mm2. Dalam ujian kekuatan lenturan, rasuk konkrit dengan penggantian 0% juga mencapai kekuatan lenturan tertinggi dengan 3.5.648 N / mm2. Penggantian agregat halus optimum dalam penyelidikan ini ialah penggantian 10% kerana ia masih mencapai kekuatan maksimum yang diperlukan untuk konkrit dan sesuai dengan aplikasi konkrit bertetulang yang biasa di dalam bangunan yang bertujuan untuk bekerja sekurang-kurangnya 50 tahun.

ABSTRACT

Concrete is one of the oldest manufactured construction material used in construction of various structures around the world. Due to its high demand, the material used for concrete production depleting every year. Nowadays, demand for cement sand and gravel continues to increase in concrete production. Excessive sand mining will lead to the degradation of riverine environment. An indiscriminate and illegal sand mining has created many problems in the environmental setting and water quality of the river basin. In this study, local power plant waste was used as replacement of cement and fine aggregate. This investigation is carried out to investigate the performance of concrete using fly ash and bottom. There are 3 types of mix Used in this study and the percentage of fly ash is fixed on 25% and while the bottom ash ranges between 0%, 5%, and 10%.The cement and fine aggregate replacement level were cast before subjected to water curing for 7, and 28 days. Slump test, compressive strength test, and flexural strength were conducted in accordance to the existing standard. The slump value decreased with increase in the replacement level of sand by bottom ash. The percentage of water absorption of the concrete increased with increase in the replacement level of sand by bottom ash. Respectively. Besides that, concrete with 10% coarse aggregate replacement achieved a high compressive strength which is 34.436 N/mm^2. In flexural strength test, the concrete beam with 0% replacement also achieved the highest flexural strength with 3.5.648 N/mm^2. The optimum fine aggregate replacement in this research is 10% replacement as it still achieved the maximum requirement strength of concrete and is suitable in typical reinforced concrete application in building which intended working life is at least 50 years.

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LIST OF SYMBOLS

0c	Degree Celsius
G	Grade
%	Percentage
Δ	Tolerance to Accommodate fixing precision

LIST OF ABBREVIATIONS

F	Fly ash
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
SiO_2	Silicon Dioxide
Al_2OH_3	Aluminium Trioxide
Fe_2O_3	Ferric Oxide
Kg/m^3	Kilogram per meter cube
Mpa	Mega Pascal
lbs	Pound
pints	Unit of Volume
L	Litre
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
Mw	Saturated Weight
N	Newton
SSA	Sewage Sludge ash
WBA	Wasted Bottom Ash

CHAPTER 1

INTRODUCTION

1.1 The Background of Study

Approximately, about 10 billion cubic meters' concrete is being produced yearly. Cement is a very important constituent of concrete. In 2017 approximately 4180 million tons of cement were produced globally. Production of one ton of cement releases approximately one ton of CO2 which makes up 7% of all CO2 emissions produced globally. It is a pressing need today for the concrete industry to produce concrete with lower environmental impact, these-called green concrete. It can be possible to achieve in three different ways.

The cost of conventional building materials continues to increase as the majority of the population continues to fall below the poverty line like continents in Africa and Asia. Thus, local materials as alternatives for the construction of functional but low-cost buildings in both the rural and urban areas are required to search & promote. The researchers are inspired by the concept of environmentally friendly technology to do more in protecting the environment. In most developing countries, it has become the popular way to utilize the waste material as alternative building material to overcome the environmental problem. Waste material such as fly ash and bottom ash has great potential to be used as construction material.

The fly ash and bottom ash waste materials can be easily obtained the power plants in Malaysia. The coal power plants were introduced as a raw material for power generation since 1988 in Malaysia. The existing coal-fired power plants in Malaysia are Sultan Azlan Shah Power Station, Manjung Perak (3 x 700 MW) commissioned in 2003, Sultan Salahuddin Abdul Aziz Power Station Kapar (4 x 300 MW, 2 x 500 MW) commissioned in 1988, Tanjung Bin, Pontian, Johor (3 x 748 MW) commissioned in

2005 and Jimah Port Dickson (2 x 752 MW) commissioned in 2008. Sarawak has two coal fired-power plants which are Mukah (2 x 135 MW) and Sejingkat (2 x 50 MW, 2 x 55 MW) (Coal-Fired Power Plants in Malaysia, 2010).

Looking at the electricity generation mix, the percentage of coal usage remains stable at an average of 8.6 percent from 1993-2000 and increased slightly to 12 and 14.1 percent in 2001 and 2002 respectively. However, in 2003, the percentage increased tremendously from 14.1 percent to 24.6 percent of coal in the electricity generation mix due to the commissioning of Janamanjung power plant. the power plants in Malaysia utilizes 21 million metric tons of coal annually with the present generating capacity of 9,477MW. By 2020, coal-fired plants will make up 64% of total installed capacity compared to 45% in 2014 due to additional coal capacity of 5,010MW. As a result, annual coal consumption is expected to increase by more than 75% from existing utilization rate to 40 million metric tons by 2020.

Fly ash and bottom ash possess properties that give them several productive uses as construction materials, and more than 70 percent of the ash remains unused (ACAA, 1998). The majority of unused coal ash is disposed in landfills or mined out areas of coal mines prior to their reclamation. The geotechnical, geochemical and mineralogical properties of the coal combustion products may vary from individual sample depending on the type of raw materials, feedstock handling and inflammation condition.

In this study, fly ash and bottom ash from power plants in Malaysia will be used. Basically. The type and origin of coal burned, boilers type, degree of pulverization, firing conditions in the furnace and ash handling practices will affects the characteristics on physical, mechanical and chemical of the fly ash and bottom ash (Huang, 1990). Although there are a lots of studied related to the properties of coal ash, but the investigation about the local coal ash is very limited. Therefore, it is necessary to provide the information based on the laboratory and field education of the locally available coal ash particularly the fly ash and bottom ash for potential construction.

1.2 Problem Statement

World cement demand and production are increasing the total output of cement in the world reached 4,180 million tons in 2017. The production of cement is increasing dramatically in developing countries. It was expected that by 2020, the global demand for cement would increase by approximately 115–180% compared to 1990s, and this may reach 400% by 2050 (Damtoft et al.,2008).

A conservative estimate for every 1 tons of cement produced gives approximately of 0.9 tone of CO_2 (Benhelal et al., 2013). Not only CO_2 is released from cement industry, but also SO_2 and NO_x, which can cause the greenhouse effect and acid rain. This is particularly serious in the current context of climate change caused by carbon dioxide emissions worldwide, causing a rise in sea level and the occurrence of natural disasters and being responsible for future meltdown in the world economy (IPCC, 2007).

Production of cement not only causes a problem to the environmental, but also consumes considerable amounts of virgin materials, producing each tone of cement of which around 1.5 tons of raw materials is needed (Elchalakani et al., 2014). In addition, cement production is highly energy intensive (Mikulcˇic´ et al., 2016). One of the efforts to produce more environmental friendly concrete is to replace large amount of cement in concrete with by- waste product materials in large volume such as fly ash and bottom ash to decrease environmental impact and enhance economic benefits.

In addition, the disposing of ash in landfills contributes to the ongoing problem of diminishing landfill space in the Malaysia. And at the same time, ash disposal of landfilling may pose leachate of heavy metal to the ground and water sources. Changeability of fly ash and bottom ash are a latency problem because of the variability in type and origin of coal burned, boiler types, degree of coal pulverization, firing conditions in the furnace and ash handling practice (Huang, 1990). There is a requirement for a systematic manner to estimate locally available fly ash and bottom ashes for potential construction utilization because even fly ash and bottom ash produced from unitary source can be entirely difference depending on the Operating conditions and procedure.

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