UNIVERSITI PUTRA MALAYSIA

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APPROVAL SHEET

This project report entitled,**" The properties of Special Concrete using Bottom Ash"**, prepared and submitted by **Zulkifle bin Muda** in partial fulfillment of requirement for Degree of Master of Science (Structural Engineering and Construction) is hereby accepted

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ABSTRACT

This report presents an experimental study to determine the behavior of Special Concrete containing Bottom Ash that was obtained from TNB Janamanjung Coal Power Plant Sdn. Bhd. in Manjung, Perak. This study involved two phases of experiments: 1) Chemical and physical analysis of bottom ash samples 2) The determination of properties of hardened concrete. The properties of hardened lightweight concrete were determined inclusive of compressive strength, ultrasonic pulse velocity and chemical composition, microscopic aspects and durability of hardened concrete.

In this study, bottom ash was used as partial replacement of cement and sand in special concrete with the bottom ash being used as 10, 20, 30 and 40 percent of normal Ordinary Portland Cement (OPC). Zero percent bottom ash was used as control sample. For each mix, a total of 15 cubes (100mm x 100mm x 100mm) specimens were prepared. All concrete specimens were subjected to Ultrasonic Pulse Velocity Tests prior to crushing test.

Its compressive strength was tested at curing the ages of 3, 7, 14, 28 and 56 days and subsequently further analysis using Scanning Electron Microscopes (SEMS) and Energy Dispersive X-Ray (EDX) Analysis were conducted.

Durability test was also conducted to monitor the effect of Iron Pyrites in the bottom ash concrete.

The test results showed that the replacement of cement and sand in concrete mixtures have caused the reduction in the workability of fresh concrete and also

the compressive strength of concrete. The maximum compressive strength of concrete occurred at 10 percent replacement with bottom ash.

In cement replacement, the results from curing in the accelerated curing tank proved that bottom ash was an inert material and it did not help the hydration process of concrete. Besides, the addition of bottom ash will lower the strength of concrete due to the reduction in cement content in the concrete.

In sand replacement, the reduction of compressive strength was possibly due to reduced density of concrete as a result of high porosity of concrete after addition of bottom ash.

Bottom ash exhibits a long term compressive strength higher than normal OPC concrete. The higher long term compressive strength of partially substituting cement and sand with 10 percent bottom ash is clearly demonstrated by the compressive strength of concretes at 56 days.

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INTRODUCTION

1.0 Background

The production of coal ash from the existing 2 x 300MW Units of TNB Coal-fired Thermal Power Station at Kapar, Klang is about 400 tonnes a day (200,000 tonnes annually). This figure is not included the coal ash production from the new installation of 2 x 500 MW Steam Turbines at the same place. Furthermore, TNB Janamanjung Sdn. Bhd., a new coal power station in Malaysia, has been in operation since 2002 will add thousand tonnes of bottom ash annually. From 200,000 tonnes of coal ash, 80% is fly ash (collecting in the Electrostatic Precipitator) while 20% is bottom ash collecting at the boiler furnace bottom hopper [3]. Most of the Pulverized Fly Ash products from TNB Coal-Fired Thermal Power Stations at Kapar and TNB Janamanjung at Manjung have been utilized by local cement companies for many years. Unfortunately, the bottom ash is still left unattended in the ash pond without proper utilization.

The stakeholders of the electricity companies have to consider the requirement of additional Ash Pond to cater the increasing production of bottom ash annually. Several efforts have to be made to utilize the bottom ash since this material is being dumped in the existing ash pond beside the power station that requires large areas.

According to **Neville**, ***"Portland cement was considered as the best, if not the sole, cementitious material in concrete. When other materials,***

primarily Pulverized Fly Ash and Ground Granulated Blast furnace Slag were introduced, they were viewed as replacements or substitutes for cement and also aggregate and their influence and performance were judged against the standard of concrete containing only Portland cement."

Based on Neville statement above, bottom ash has a potential to be utilized for replacing cement or aggregate particularly in a variety of manufacturing and construction applications. There are many literatures available regarding various applications of bottom ash not only in geotechnical field such as structural landfill, roller compacted concrete and road works but also in structural concrete works and lightweight concrete block and paving blocks.

The topic for this project is the Properties of Special Concrete Using Bottom Ash. The bottom ash used for this project will be obtained from TNB Janamanjung Coal Power Plant Sdn. Bhd. in Manjung, Perak.

1.1 Project Main Objectives

The objectives of this project are:-

a).To study chemical and physical properties of Bottom Ash

b).To study its use in Lightweight Concrete

1.2 The Scope of Works

This study can be divided into two stages as the followings:-

1. To conduct various analysis and testing in order to determine chemical and physical properties of bottom ash sample.
2. To determine the physical properties of the fresh and hardened concrete containing bottom ash and compared with control mix concrete.

The first stage is a feasibility study shall include chemical analysis using modern facilities at TNB Research Sdn. Bhd. and subsequently physical analysis of bottom ash sample at Ikram Research Centre Sdn. Bhd., and University Putra Malaysia. There are six types of chemical analysis will be conducted such as Scanning Electron Microscope Analysis (SEMS) and Energy Dispersive X-Ray (EDX),

X-Ray Diffraction Analysis (XRD), Inductive Coupled Plasma (ICP), Proximate Analysis and Ultimate Analysis to determine various chemical composition of the original and washed bottom ash samples. The physical properties of the bottom ash are obtained based on various testing such as Sieve Analysis, Fineness Modulus, Specific Gravity, Bulk Density and Water Absorption according to British Standard.

In the second stage, bottom ash will be used as a replacement for cement and sand in concrete ranged from 0%, 10%, 20%, 30% and 40% with a fixed water-cement ratio of 0.50. The control mix without bottom ash will be proportioned as per normal OPC concrete.

The trial mixes will be conducted for each type of mix in order to obtain the respective workability or slump and compressive strength of the design mix prior to the actual mixing of concrete. The slump tests will be carried out for each fresh concrete to determine and monitor the workability of the concrete. The accelerated curing tank will be used to study the behavior of bottom ash in the hydration process.

The hardened concrete samples will be subjected to Ultrasonic Pulse Velocity Test and Compressive Strength Test in complying with British Standard accordingly. Furthermore, the photomicrographs and chemical composition of the hardened concrete at various curing age for each mix will be obtained using Scanning Electron Microscope Analysis (SEMS) and Energy Dispersive X-Ray (EDX), at TNB Research Sdn. Bhd and SIRIM Bhd.

There are about 180 samples of concrete cubes to be cast, which consist of 15 samples of cubes, 6 cylinders for each concrete mix. The tests on hardened concrete cubes will be carried out at the age of 3, 7, 14, 28 and 56 days respectively.

The potential of converting this coal ash into valuable concrete products will be evaluated through the chemical and physical analysis of bottom ash and its utilization in the special concrete. Therefore, this research will add some knowledge and information regarding the utilization of bottom ash which will benefit not only the coal ash producer but also the concrete industry in Malaysia.

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