THE ANALYSIS OF HEAT TRANSFER OF THE ECO POZZOLAN MIXTURE WITH CONCRETE AT HIGH TEMPERATURES

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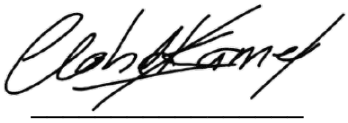

DECLARATION

I hereby state that this thesis has not previously been submitted to any other university for any degree. It was submitted to University Malaysia Sabah (UMS) as partial fulfilment of the requirement for the degree of Bachelor of Mechanical Engineering. Additionally, I attest that the content of this document is entirely mine, with the exception of quotations and summaries, the sources of which have been properly cited.

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3rd July 2022

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ABSTRACT

The purpose of this project is to conduct the analysis of heat transfer of the eco pozzolan mixture with concrete at high temperatures, and to compare the performance of EPP Class C (ASTM C618) to the basic concrete mix. As well as how much the performance of EPP in ratio to the OPC gives the better or no less results, and lastly how combining two aggregates somehow gives best heat transfer performance to the set. The lower heat transfer, the better heat insulation of the concrete will be, and the longer time taken for inner and outer wall be same also shows the better insulation of the concrete will be. Next, this set is conducted in cylinder form of mould because of same heat dissipation and flows into the concrete. Measuring the heat differences using Dual Channel Thermocouple, where T_2 is at the outer wall of the cylinder and T_1 is in the inner wall of the cylinder. Heating process experiment will be conducted in furnace oven with setting of 300˚C. But aware that this experiment has not been done in thermal conductivity test experiment before proceeding with the experiment. Using citation and summary from selected journal for basic concrete and pozzolana concrete with its own OPC/water ratio good enough to assume and taking consideration to use the thermal conductivity for this experiment.

ABSTRAK

(ANALISIS PEMINDAHAN HABA CAMPURAN ECO POZZOLAN DENGAN KONKRIT PADA SUHU TINGGI)

Tujuan projek ini adalah untuk menjalankan analisis pemindahan haba campuran eko pozzolan dengan konkrit pada suhu tinggi, dan untuk membandingkan prestasi EPP Kelas C (ASTM C618) kepada campuran konkrit asas. Serta berapa banyak prestasi EPP dalam nisbah kepada OPC memberikan hasil yang lebih baik atau tidak kurang, dan akhir sekali bagaimana menggabungkan dua agregat entah bagaimana memberikan prestasi pemindahan haba terbaik kepada set. Pemindahan haba yang lebih rendah, penebat haba konkrit yang lebih baik akan menjadi, dan lebih lama masa yang diambil untuk dinding dalam dan luar adalah sama juga menunjukkan penebat konkrit yang lebih baik. Seterusnya, set ini dijalankan dalam bentuk silinder acuan kerana pelesapan haba yang sama dan mengalir ke dalam konkrit. Mengukur perbezaan haba menggunakan Dual Channel Thermocouple, di mana T_2 berada di dinding luar silinder dan T_1 berada di dinding dalam silinder. Eksperimen proses pemanasan akan dijalankan dalam ketuhar relau dengan penetapan 300°C. Tetapi sedar bahawa eksperimen ini belum dilakukan dalam eksperimen ujian kekonduksian sebelum meneruskan eksperimen. Menggunakan petikan dan ringkasan daripada jurnal terpilih untuk konkrit asas dan konkrit pozzolana dengan nisbah OPC/airnya sendiri cukup baik untuk mengandaikan dan mengambil kira untuk menggunakan kekonduksian terma untuk eksperimen ini.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In our day-to-day lives, the environment is simply the area in which all non-living and living entities coexist and develop a relationship. Soil, water, air, animals, and humans are all components of the environment. All of the benefits supplied by the natural environment are beneficial to all living organisms, particularly people. Natural resources are so vital to life that it would be impossible to live without them. The fast growth of the world's population has resulted in an increase in the demand for commodities and materials by a very big population. Environmental components and other natural resources are regularly and significantly abused and overexploited, well beyond natural limitations (AllAnswers. 2021). The overexploitation and abuse of these natural resources is extremely detrimental to both human and animal health. Which lead to that is why people extracting so many natural resources from the earth especially cement ingredients such as limestone and marl. On the other hand, carbon footprint from the cement itself releases the amount of carbon dioxide into the atmosphere or by far same definition as total amount of greenhouse gases (GHG) (carbon dioxide, CO_2) transmitted to the air.

To be exact, mixture of eco pozzolan (which is easily accessible) to the mix of cement will reduce the usage of cement 100% while has advantage to it. One of them is it will reduce the carbon dioxide emission to the air. This is because, one of the most significant advantages of lowering carbon emissions is that it would reduce the number of fatalities caused by air pollution, easing pressure on healthcare systems (Earth. Org, 2020). Next, the analysis as on how as on how to describe the purpose of analysis of heat transfer of the eco pozzolan mixture with concrete at high temperature. Therefore, research explain is to evaluate how eco pozzolan mixture with concrete will bear the high temperature and how it can sustain the ability for a

long period of time. This is because, heat is a crucial subject to grasp in a variety of engineering domains such as insulation design material. Because heat transfer is important in material selection, equipment efficiency, and reaction kinetics, it is especially important for civil, mechanical, and chemical engineers. To show how heat transfer pertains to engineering in this session and will be challenged to identify examples of engineering projects that have used heat transfer scientific concepts. This study is important as why concrete alone is not as good as it need reinforcement. Explains that plain concrete has tensile stress weak, it requires extra reinforcing. Plain concrete, without reinforcements, is prone to cracking and collapse due to its inability to handle massive quantities of tensile pressure (Concrete.org, 2021)

Eco pozzolan one of material used for reinforcement is material that has been eco-processed is a long-lasting product made from leftover bleaching earth. Generally, eco pozzolan or Pozzolana is a widely recognised term that is commonly used in the construction sector nowadays. Pozzolana is a volcanic ash which is natural pozzolan that is used as a cement alternative. Pozzolana is a siliceous and aluminous mineral component found in pozzolanic materials. Pozzolanic materials are classed as natural or manufactured based on their sources of origin. To make pozzolana Portland cement, pozzolanic ingredients including fly ash, rice husk, and silica flume are mixed together with standard Portland cement. Pozzolanic materials aid in the reduction of OPC formation, which lowers the quantity of CO_2 emitted into the environment (Ritesh Patel, 2018). This mixture is generated as a waste item in the refinery plant as a result of palm oil processing. Despite the fact that dumping the waste in a landfill might pollute the environment, therefore it is recovered and used to make sustainable goods. So to conclude, in this study want to prove how incorporation of eco pozzolan mixture will strengthen the concrete in term of the ability to sustain the heat transfer especially at the high temperature.

1.2 PROBLEM STATEMENT

The manufacturing of the conventional building material such as conventional concrete alone is not better enough. What a cost-effective solution that needed to implement in nowadays manufacturing industry or any other industry that uses concrete especially building aspect. This is because the manufacturing industry has seen an unprecedented period of fast development, resulting in changes in management strategies, technological implementation, consumer expectations, and natural rivalry and economical solution.

Therefore, to see on how plain concrete at high temperature is not sustainable and good as it need to sustain the high heat transfer, this plain concrete as it need the reinforcement to strengthen it. But there is a catch, the mixture can be variable from cement, aggregates such as gravel or sand, or either steel. These reinforcement materials as used in mixture to propose the higher early and its ultimate strength, to increase the durability of the concrete and as to save time in aspect of repair and maintenance and lastly its heat transfer. These materials also variable in cost as it need to reinforce the concrete. That is why eco pozzolan is a great choice since it a recycled product and cheaper and might be better compared to the other option that needed to be extract from the earth. Therefore, this solution of using eco pozzolan is determined by its ability of retraining the heat transfer at high temperature and to see how the purpose of the analysis is to demonstrate how an eco-pozzolan combination with concrete can withstand high temperatures and maintain its ability over time.

1.3 RESEARCH OBJECTIVES

The main objective of this study is to identify and analyse the ability and implementation of eco pozzolan mixture with concrete as it is:

1. To evaluate heat transfer thermal conductivity for 100% OPC .
2. To determine the optimum mixture of eco pozzolan for the best performance.
3. To analyse the heat transfer to the mixture of concrete with eco pozzolan at high temperature.
4.

1.4 SCOPE OF WORKS

1.4.1 PRELIMINARY LITERATURE REVIEW

Before beginning the experimental phase, a preliminary literature study will be undertaken. To completely comprehend the basic notion of this research, a literature review will be undertaken. To produce the literature for this study, a variety of sources will be used, including books, peer-reviewed journals, and articles.

1.4.2 BOARD PREPARING

The preparation board is a frequent means of presenting the outcomes of a data analysis, programme evaluation, or other project at professional gatherings by displaying a display that effectively explains the study goals, processes, results, and consequences to a wide range of professionals. Various groups will inquire about various aspects of the study topic while presenting the project's concept via posters. Others may undertake policy work or analysis on a specific problem or with associated data or techniques. By having a fresh understanding of science, this will assist to improve the quality of research.

1.4.3 EXPERIMENTAL CHECKING

The goal of this experiment is to focus on preparing or testing whether or not the objects are ready to be used in a lab test. This phase focuses on getting all of the materials in good working order.

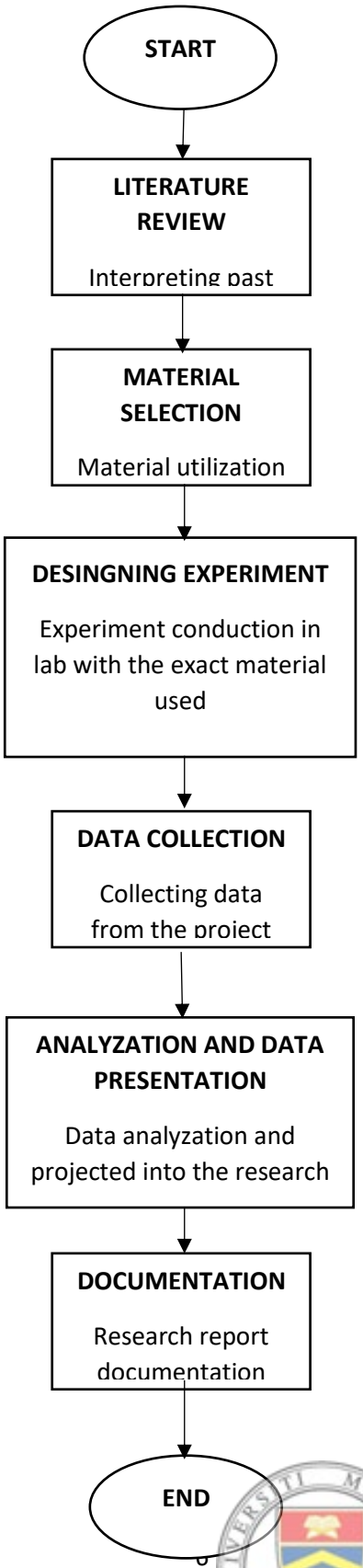
1.4.4 LAB TEST CONDUCTION

In a month, data taken from the analyzation heat transfer of mixture of eco pozzolan and concrete at high temperature in the lab FKJ UMS. This experimentation basically to see the mixture of eco pozzolan to ordinary cement and to see the heat transfer of the mixture at high temperature. Measurement to the mass of eco pozzolan and concrete need to be measure or the ratio of each product used. And the experimentation of heat transfer to the mixture is conducted using oven and temperature be measure using thermocouple.

1.4.5 ANALYSIS OF RESULT/DATA

After conducting the lab test, the result can briefly explain and to analyse the heat transfer to the mixture of concrete with eco pozzolan at high temperature. While learning on to investigate the characteristic of eco pozzolan as material concrete reinforcement and to come up with the outcome to see the optimum mixture of eco pozzolan for the best performance.

1.5 METHODOLOGY



1.6 METERIALS EQUIPMENT AND MATERIALS

This project will require the use of the following equipment and materials:

1. Eco Pozzolan
2. Portland Cement
3. Oven Furnace
4. Thermocouple
5. Sand
6. PVC

1.7 RESEARCH EXPECTED OUTCOME

This research will determine the ability of to gather information and data needed whereas to determine the analysation of heat transfer to the mixture of eco pozzolan with concrete. Next, the determination of optimum mixture of eco pozzolan to see its performance and how it will improve the overall stability of concrete especially in its heat transfer. Lastly, characteristic of eco pozzolan as material reinforcement also can be seen in the expected outcome.

1.8 RESEARCH CONTRIBUTIONS

At the conclusion of this research, will be able to suggest process modifications for boosting concrete improvement in heat transfer with the mixture of eco pozzolan compared to other material reinforcement. Demand for the better cost-effective improvement is one of the efforts how to save the environment. Using eco pozzolan as one of the concrete reinforcements is best way to improve the stability especially in its heat transfer compared to the other options. By performing this study, not only will other researchers be able to learn more about the benefits of using eco pozzolan as a concrete reinforcement for heat transfer, but it will also help to educate the public about how to use and utilise eco pozzolan in our industry.

1.9 RESEARCH COMMERCIALISATION

For future research and development, as well as a reference to the alternative of common concrete material reinforcement especially in heat transfer since it has good cost and availability. This one of the better option or choice among the construction industry concrete material reinforcements to be used in construction industry. As we know, other concrete reinforcement might not be tolerating in prices, this will save more cost for construction while eventually save the cost of client's budget as well.

CHAPTER 2

LITERATURE REVIEW

2.1 THE PRODUCTION OF ECO POZZOLAN

2.1.1 OVERVIEW

According to (Concrete.org, 2021), eco pozzolan or most likely to be known for pozzolan is seems to be a siliceous or siliceous and aluminous substance that has little or no cementitious value in isolation but may chemically react with calcium hydroxide in finely split form and in the presence of moisture at ordinary temperatures to generate compounds with cementitious qualities.

Historically, Pozzolana was initially discovered near Naples, at Puteoli (modern Pozzuoli), where there are still huge beds, and also in the Rome 25 miles east of Mount Vesuvius, which distinguished it from river and sea sands (the common harena). The majority of natural pozzolana is made up of a fine chocolate-red volcanic soil. Industrial, manufactured pozzolans are made in furnaces that burn organic resources like coal and then recycle the ash. The most frequent type of industrial pozzolan is fly ash. The key to Roman cement was the combination of lime and pozzolana, which Vitruvius referred to as harena fossicia or "pit sand." Pozzolana was named after the town of Pozzuoli (Roman Puteoli, near Baiae) in the Bay of Naples, Meter-thick strata of pozzolana, volcanic pumice, and ash from past eruptions blanket the whole area (Webb. P, 2017).

But there are two categories divide up pozzolan which are artificial and natural. According to (Serasre. R, 1980) 10, natural pozzolanas are made up of volcanic ash and dust that has been subjected to quick cooling and, in some cases, significant chemical modification. The impact of superheated steam and carbon dioxide below the earth's surface has been to transform most of the original components into a more chemically reactive modification, while the basic ingredients

have been largely eliminated under the combined influence of carbon dioxide and water. The volcanic glass is responsible for the pozzolanic characteristics of volcanic materials. Volcanic ash with a high percentage of crystalline minerals is more stable and has less pozzolanic action. While for the artificial pozzolan is coming from variety of source which are from process of spent bleaching earth (SBE). Some of them is from recycled product and sustainable for example pulverized coal and rice husks. First, pulvarized coal according to (Dhir. R, 1986) is burned in boilers, the ash that results are about spherical in form. Pulverized fuel ash (PFA) is a kind of ash with pozzolanic characteristics. It is mostly made up of glassy siliceous elements, which mix with hydrated lime during cement hydration. Fine pulverisation of the coal before burning speeds up the interaction of PFA with hydrated lime. It can also be improved by finely grinding the fly ash in a ball mill (Hubbard. R, 1986) and using efficient wet curing at high temperatures. Because of the spherical form of the glass particles, PFA increases concrete workability and retards C_3A hydration owing to its SO_3 concentration, resulting in long-term workability (Lane. R, 1982). PFA reactivity with hydrated lime to create cementious material can be noticed as early as a few hours after mixing (Owens. P, 1980) 14. While for the rice husk is solid waste products derived from rice processing plants. Their disposal options include open field burning or use as a source of fuel. Rice husk ash (RHA) is used in rice farms to boost yield and as a fertiliser anti-caking agent (Swamy, 1983). Due to its inert state, these approaches do not completely use its high silica concentration. Pozzolanic RHA is created when RH is burned under regulated conditions. The high silica content and high proportion of ash by weight in RHA as a cement is attributable to its high silica content and high percentage of ash by weight in plant residues when compared to other plant wastes (Cook. D, 1995).

Table 2.1 below from (Cook, 1995) shows some of the artificial pozzolan source that has been through process of spent bleaching earth including went through different temperature process. Included below contains percent of ash and silica and from in which part of the plant.

Table 2.1 Portion of Ash and Silica contain in Plant Source

Source	Part of Plant	Ash%	Silica%
Sorghum	Leaf sheath epidermis	12.55	88.70
Wheat	Leaf sheath	10.4	90.56
Corn	Leaf blade	12.15	64.32
Bamboo	Nodes (inner portion)	1.49	57.00
Sugarcane	Bagasse	14.71	73.00
Lantana	Leaf and stem	11.24	23.28
Sunflower	Leaf and stem	11.53	25.32
Rice	Husks	22.15	93.00
Rice	Straw	14.65	82.00
Breadfruit	Stem	8.65	81.80

Source: (Cook, 1995)

2.1.2 SPENT BLEACHING EARTH (ECO OIL COMPANY IN LAHAD DATU)

EcoOils Sdn Bhd is a participant in the Lahad Datu palm oil industrial cluster (POIC Lahad Datu), a byproduct of its industrial-grade palm oil recovery facility. EcoOils, located in Singapore, extracts industrial grade palm oil from wasted bleaching earth, a waste product from palm oil refineries, and utilises it to make a variety of downstream goods. Pozzolan, a kind of ash, is one of the zero-waste plant's by-products. CIS is a state-owned corporation that produces cement at two plants: one in Sepanggar and another in Lahad Datu. It is Sabah's largest cement producer (Pressreader, 2021).

According to (K.Y. Cheong, 2013), spent bleaching earth (SBE) is a solid waste product of the palm oil industry's bleaching process. This solid waste is currently disposed of without treatment in landfills, resulting in significant water and air pollution. Most nations have recently made it illegal to discard SBE in landfills or public disposal sites. Meanwhile, the significant expenses connected with the vast amount of land required for residue storage have sparked interest in regenerating SBE. As a result, a recent unique approach to the use of SBE in agriculture as an alternate form of disposal has been carried out. The pre-treatment of crude palm oil (CPO) in a refining process that includes degumming and bleaching produces a large amount of discarded bleaching earth (SBE). Based on the global output of more than 60 million tonnes of oils, it was projected that around 600,000 metric tonnes or more of bleaching earth were used in the refining process (E.Y. Park, 2004). SBE is a waste product from the palm oil refinery (POR) that has a significant amount of residual oil (20-40%) (S. K. Loh, 2006). SBE is commonly disposed of through cremation, inclusion in animal feeds, land filling, or concrete manufacture. The current most popular approach in Malaysia is landfill disposal, which poses fire and pollution risks due to the degradation of residual oil and accompanying greenhouse gas (GHG) emissions during disposal. Other investigations on SBE regeneration in various applications include residual oil recovery for biodiesel production (P. V. Lara, 2004) and its usage as an adsorbent (C. H. Weng, 2007).