SELF-HEALING GEOPOLYMER MORTAR

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DEDICATION

This project report is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Waste material from industrial product increase annually in Malaysia and become interesting topic on how to reduce recycling rate for sustainable eco-system. The application of geopolymer technology has become important around the world in preserves the environment from polluted. Furthermore, geopolymer contributed for less carbon dioxide emission and labelled as free cement content. The issue on defect are mainly concern after the construction because of several factor could cause structural or non-structural defect. In other hand, people perception about bacterial also be discussed in this research and give further explanation on their beneficial for ecosystems and construction industrial. This research presented an assessment on mechanical properties and self-healing in geopolymer fly ash mortar with addition effective microorganism in the design mixed. The development of new materials such effective microorganism that contribute like self-healing materials are needed to repair crack automatically and to restore or even increase mortar strength to prolong its service life. There are three type of specimens for different purposes in achieving research goal and testing of method or this research involving compressive strength test, self-healing test and permeability of geopolymer mortar The specimens have been cast and proper curing as follow as designed. Self-healing concept is discussed in detail result followed by the experimental program. . For conclusion, the aims to get ultimate strength from specimens and self-healing performance were successfully with experimental result. For further study are stated in recommendation.

ABSTRAK

Bahan buangan daripada produk industri di Malaysia meningkat setiap tahun dan ini menyebabkan menjadi bualan masyarakat tentang bagaimana untuk mengurangi kadar kitaran bahan buangan. Kegunaan geopolimer menjadi salah satu teknologi yang penting dalam menangani pencemaran alam sekitar. Seterusnya, geopolimer telah menjadi penyumbang dalam mengurangan pelepasan karbon dioksida dan di iktirafkan sebagai produk yang bebas dari pengunaan simen. Isu tentang kecacatan menjaadi perhatian yang disebabkan oleh beberapa factor kecatatan pada struktur mahupun kecacatan pada bukan struktur selepas pembinaan. Di samping itu, persepsi manusia terhadap bakteria juga dibincangkan dalam penyelidikan ini dan menerangkan tentang kebaikan bakteria kepada ekosistem dan industri pembinaan. Penyelidikan ini dibentangkan untuk menilai sifat-sifat mekanik dan prestasi dalam penyembuhan diri bagi mortar geopolimer yang mengandungi EM. Perkembangan bahan baru seperti EM ini mampu menjadi bahan ejen untuk penyembuhan diri dalam menbaiki retakan yang berlaku secara automatic. Tambahan pula, EM mampu meningkatkan kekuatan mortar dalam memanjang hayat hidup. Terdapat tiga jenis spesimen untuk tujuan yang berbeza dalam mencapai matlamat penyelidikan dan ujian kaedah atau kajian ini yang melibatkan ujian kekuatan mampatan, ujian penyembuhan diri dan kebolehtelapan mortar geopolimer. Spesimen telah dibuang dan pengawetan yang sesuai seperti yang dirancang. Konsep penyembuhan diri dibincangkan secara terperinci diikuti oleh program eksperimen. . Untuk kesimpulan, matlamat untuk mendapatkan kekuatan muktamad dari spesimen dan pencapaian penyembuhan diri berjaya dengan keputusan percubaan. Untuk kajian lanjut dinyatakan dalam cadangan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Problem Background

The infrastructure in Malaysia are popular for their unique design and creativeness such bridge, road and building. Such constructions took place in the developed world during the middle of the last century and they are facing the challenge of maintenance and renewal. The emerging economies are rapidly building their infrastructure now. As a result, consumption of building materials has grown at a very fast pace and would continue to grow the needed for the operation of a society or enterprise.

Cement is the most widely used manufactured material in existence. It forms when fine aggregates mixed with water, and used in the construction of everything from buildings and bridges to roads and sidewalks and all kinds of other infrastructure. But while cement has largely shaped in the modern built environment, it is also a massive source of carbon dioxide to the atmosphere. It single-handedly accounts for about 7 percent of all global carbon emissions, according to estimates from the International Energy Agency. That makes it the second-largest single industrial emitter in the world, second only to the iron and steel industry. Furthermore, the structural reliability itself has been doubt because several damages occur in the building should be sustained for next 50 years by showing sign of building condition.

The construction industry is the one of top global consumer of virgin materials. The industry generates about 25 to 40 percent of the world's carbon emissions. This volume of natural resource utilization is not sustainable and could compromise the environment for the sake of growth. The demand for materials for the construction industry also need to meet strictly structural requirement which are material properties

can produce good strength of structural or non-structural element itself and it must be friendly with ecosystem.

There were many of innovative ways to cope these problems. But it seem not working and not being practical in real construction. However, this decade shown that geopolymer concrete has demonstrated a promising capability as a new potential alternative of cement to be deployed in construction field. It is because, geopolymers have excellent quality properties for instances low shrinkage, fast or slow setting, acid-resistance, thermal conductivity, and high compressive strength (Ali et al., 2015; Hardijo and Rangan, 2005)

Agriculture waste is a serious environmental problemin many countries. These waste was dominantly produced from garden and rice field. Concerning the eco-logical sustainability, the importance of recycling, finding economical fruit by-product is one important approach to protect environment. The majority of previous research involving agriculture waste consist of Palm Oil Fuel Ash (POFA) (Abdul and Abubakar, 2011; Yong et al., 2014; Ahmad Hussein et al., 2017) and Rice Husk Ash (RHA) (Habeb and Mahmud, 2010; Kartini and Ir, 2011; Kawabata et al., 2012) as binder.

Hardijito et al., (2010) stated that when polymerisation stage, geopolymers do not release hazardous greenhouse gases, thus, are classified as environmentally friendly materials. In fact, geopolymers only require a moderate amount of energy to produce. Commonly, geopolymers consist of source materials with Aluminium (Al) and Silicon (Si) content which can be established by using fly ash, waste-product generated from coal-fired power station, as the source materials. Interestingly, only a little attention has been devoted to investigate the use of a particular bacteria to enhance the strength of geopolymers based on concrete. Hence, this research is geared towards developing a new environmentally friendly effective microorganism-based geo-polymer for construction industry.

1.2 Problem Statement

The issue on structural defect are mainly concern to be discussed on this study. There are several causes why structural or non-structural can defects occur. The defect may appear as a minor crack on structural or non-structural element, however in the long term, it can lead to cause collapse the whole entire element. Basically, the major causes for this problem are unsuitable construction material and poor construction practices. In addition, many people that involved in construction are afraid to use bacteria in their concrete design as a self- healing agents in overcome the problem. The perceptions of using bacteria in the concrete become attention because of bacteria has a negative effect on human health. The mechanism of self-healing by using bacteria is the formation of calcium carbonate from the bacteria, based on the enzymatic hydrolysis of urea to ammonia and carbon dioxide. From this reaction, pH increasing from neutral to alkaline condition results the formation of bicarbonate and carbonate ions which precipitate in the presence of calcium ions to form calcium carbonate minerals.

1.3 Research Objectives

This research aims to assess on self-healing performance of geopolymer mortar in the presence of effective microorganism (EM). Therefore, the objectives of the research are as follow:

(a) To investigate the strength properties of geopolymer mortar with addition effective microorganism (EM).

(b) To determine the optimum usage of EM for self-healing performance in geopolymer mortar which arise in crack specimens.

(c) To examine the compressive strength of EM geopolymer mortar after preload of the specimens.

1.4 Significant of Research

This research study about the combination of EM bacteria and geopolymer mortar in produced good quality of mortar. In addition, EM bacteria is good material for agriculture industries while geopolymer was known good resistance in aggressive environment. This research study established that the addition of EM in geopolymer mortar showed an improvement in strength properties of geopolymer mortar in term of compressive strength. The ultimate design mix of geopolymer mortar obtained at 10 percent contain EM. In term of self-healing performance, geopolymer mortar at 10 percent contain EM showed better performance after preload specimens. This is due to the microorganism generate the formation of calcium carbonate in the pores present in mortar, act as filler to fill the gap in geopolymer mortar. Furthermore, EM enhanced in making the geopolymer mortar lesser permeability within the time through microstrural changes.

1.5 Research Scope and Limitations

Experimental work for this research is started to find the strength of geopolymer that containing effective microorganism with different percentages. The percentages of EM proportions in the increment of 0%, 5%, 10% and 15% replacing water content were developed. The compression test has been carried out for 7th. 14th, and 28th days. Furthermore the self-healing process of geopolymer mortar have been conducted. The quality of EM geopolymer mortar have been carried out using ultrasonic pulse velocity method as stated in IS: 13311 (Part 1) – 1992. After that, cylinder sizes of 100 x 150 mm samples were then tested for water permeability which referred in the IS 3085:1965 for Methods of Test for Permeability of Cement Mortar and Concrete (Seventh revision) -Reaffirmed,. Dec 2016.

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