EFFECT OF EFFECTIVE MICRO-ORGANISM ON TEMPERATURE VARIATION AND PROPERTIES OF CONCRETE

MD AWLAD HOSSAIN

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Faculty of Engineering
Universiti Teknologi Malaysia

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DEDICATION

This 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

In promoting sustainability in concrete, Effective Micro-Organism (EM) has been used in construction industry for the last few years. The aim of the study is to assess the effect of EM on the properties of concrete including fresh, hardened, durability and temperature variation in concrete. The research is based upon the addition of 5%, 10%, 15%, 20%, 25% and 30% of EM by replacing water in the concrete mixture. Concrete cube samples with the size of (100 x 100 x 100) mm were prepared and tested at the age of 3, 7, 14 and 28 days. The curing method was employed by water curing. Laboratory tests that had been done include temperature variation test, density test, Ultrasonic Pulse Velocity test, Initial Surface Absorption Test (ISAT) and compressive load test to assess the effects of effective micro-organisms in concrete. Results showed that compare to control sample the EM sample offered better performance in terms of all tests conducted. Using 10% of EM in sample recorded the highest compressive strength and also the lowest water penetration. It also increased the early strength of concrete significantly. On the other hand, the use of 15% of EM in concrete shows the lowest temperature rise during hardening of concrete. In conclusion, the addition of EM in concrete shows a positive effect on properties of concrete especially in temperature and durability.

ABSTRAK

Bagi menggalakkan kelestarian dalam konkrit, mikroorganisma efektif (EM) telah digunakan dalam industri pembinaan beberapa tahun yang lepas. Tujuan kajian ini adalah untuk mengenal pasti kesan EM pada sifat-sifat konkrit segar, keras, ketahanlasakan dan perubahan suhu dalam konkrit. Kajian ini berdasarkan kepada penambahan 5%, 10%, 15%, 20%, 25% dan 30% EM dengan menggantikan air dalam campuran konkrit. Sampel kiub konkrit dengan saiz 100 x 100 x 100mm disediakan dan diuji pada umur 3, 7, 14 dan 28 hari. Kaedah pengawetan dilakukan dengan menggunakan kaedah pengawetan air. Ujian makmal yang telah dilakukan termasuk ujian variasi suhu, ujian ketumpatan, ujian denyutan ultrasonik, Initial Surface Absorption Test (ISAT) dan ujian beban mampatan untuk menilai kesan mikroorganisma efektif dalam konkrit. Keputusan menunjukkan bahawa berbanding dengan sampel kawalan, sampel EM menghasilkan kualiti yang lebih baik dari segi semua ujian yang dijalankan. Dengan menggunakan 10% EM dalam sampel mencatatkan kekuatan mampatan tertinggi dan juga serapan permukaan air terendah. Ia juga meningkatkan kekuatan awal konkrit dengan ketara. Sebaliknya, penggunaan 15% EM dalam konkrit menunjukkan kenaikan suhu terendah semasa pengerasan konkrit. Kesimpulannya, penambahan EM dalam konkrit menunjukkan kesan positif terhadap sifat konkrit terutamanya dalam suhu dan ketahananlasakan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACI	–	American Concerete Institute
ASTM	–	American Standard Testin Materials
EM	–	Effective Microorganism
FA	–	Fine Aggregate
PAI	–	Pozzolanic Activity Index
SCM	–	Supplementry Cementious Material
UPV	–	Ultrasonic Pulse Velocity
WC	–	Water Cement
BS	–	British Standard
CA	–	Coarse Aggregate
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CHAPTER 1

INTRODUCTION

1.1 Introduction

Concrete has been the most common material used in construction industry for a long time. At the point when concrete is adequate to be utilized at typical development condition, its execution progresses towards becoming disintegrated when utilized in moderately adverse environment (Neville, 1971). Concrete has been used for many years because of its strength, durability and affordable price. Undoubtedly, it is the most vital element of civil and construction engineering works. Although concrete is good for resisting the compressive load of structure, but it will crack if the applied load exceeds the limit of resisting load. Beside this, one of the reasons for micro crack is temperature shrinkage, thermal contraction. Crack may reduce the durability of concrete. Also it will cause corrosion to the reinforcement if the crack width becomes too large.

Concrete technology is life-long research. The technology strives to discover the best additives or admixtures that are able to produce good concrete in terms of physical, chemical and mechanical properties in a more economical, sustainable and environmental friendly. Admixtures for concrete are known to improve the properties of concrete, indirectly increase the strength of concrete and control the temperature during early stage.

The construction industry has been investigating utilizing organic material, for example, microorganisms as the admixture for concrete. As viable microorganism was first presented in Japan with the end goal of farming, it is currently being generally utilized in different ventures around the world (Herbert 1986). A couple of studies have been completed to investigate the maximum capacity of utilizing EM its consequences for the execution of concrete and the outcomes demonstrated that there was increment

in the compressive strength of concrete containing EM (Howsam, 1990). Also by adding EM in concrete in an optimum level, it is shown that the workability of fresh concrete improves, early strength increase and maintain a lower temperature.

1.2 Problem Background

Nowadays, the increase in temperature of concrete is a major issue. During hydration process mass concrete temperature rise at a maximum level. As a result, crack occurs. And also researchers are trying to find the solution how to reduce the concrete temperature by using environmental friendly product. In previous time there were some problems that have been raised such as workability, durability, compressive strength and temperature increase during hydration process. In order to overcome such problems many research works and numerous examinations had done to investigate new materials which can be utilized as the admixtures for concrete.

In order to overcome such problems many research works had been done in previous years. As the admixture of concrete, the construction industry has been looking into using biological material such as micro-organisms. In this research, the newly discovered admixture namely Effective Microorganisms for Concrete (EMC) is studied. In the case of adding EMC to concrete, it is still at an early stage.

1.3 Problem Statement

When cement is blended with water, heat is generated. This heat is the product of the exothermic chemical reaction between cement and water. During the process of cement hydration heat is produced and it raises the temperature of concrete. During normal concrete construction, in heat generation process the heat is dissipated into the soil or the air and causes temperature difference within the structure are not significant. But in some cases, usually in heavy structures, like dams, mat foundations or any other structure more than a meter thick, the heat cannot be easily come out. The mass concrete may then experiences high internal temperatures, especially during

hot weather construction or if high cement contents are used. During the increase of temperature, thermal contraction happens in the structure and produce crack. As the construction industry is progressing, the usage of cement is also increasing exponentially so researchers are in search of stronger concrete. This increases the cement productivity globally and in turn increase the carbon dioxide emission to the atmosphere.

Cement plays the role of a binder, a substance that sets and hardens and binds all concrete constituents together. During the production and hydration process of cement, carbon dioxide is produced. Based on experimental investigation it has been proved that 1 tons of clinker produces around 1 tons of CO_2. This CO_2 production causes serious environmental damages (Patel *et al.*, 2016). Along with that, cement is a very expensive construction material. Due to higher price of cement, construction costs are quite high. It has been noted that 45% of the construction cost is related to cement (Pacheco-Torgal et al., 2010). The cement industry contributes to around 5-8% of the annual global greenhouse gas emissions to the atmosphere (Najim *et al.*, 2016). Thus, it is needed to find technique which can increase the strength of concrete without increasing the use of cement and also maintain the lower temperature rise compared to ordinary concrete for a better future.

1.4 Research Objectives

The objectives of the research are:

- To investigate the effects of EM on fresh and hardened properties of concrete.
- To assess the effects of EM in terms of temperature variation in concrete.
- To determine the effects of EM in terms of durability of concrete.

1.5 Scope of Study

The study was focused on determining the effects of effective micro-organisms (EM) on temperature variation on concrete at the early stage and properties of concrete by replacing the water with different percentages of EM (5%, 10%, 15%, 20%, 25%, and 30%). The properties of concrete which was investigated are its fresh and hardened properties such as workability, density, water absorption, compressive strength and UPV. This research does not include the cost analysis of using EM in concrete, but this also does not intend to neglect the economical aspect, rather it is believed that technical issues have to be understood and fixed right before the economical aspect of the study is determined.

So, this research project was aimed on using EM as a partial replacement of water to determine its effects on the mechanical properties of concrete and its temperature variation.

1.6 Significance of the Study

The main significance of this research is to encourage the implementation of the use of EM as an alternative ingredient to design the concrete in the construction field in order to get advantages as much as possible in order to save our economy and as well as environment. The implementation of microorganism will not only decrease environmental damages but also save the construction materials.

Thus, new techniques and materials should be developed to construct green buildings. EM is the versatile material for construction, which offers a range of technical, economic and environment-enhancing benefits.

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