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# PROPERTIES OF ACRYLIC POLYMER MODIFIED CONCRETE

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A project report submitted in partial fulfillment of
the requirements for the award of the degree of
Master of Engineering (Civil - Structure)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

NOVEMBER, 2009

I declare that this project entitled "*Properties of Acrylic polymer-modified concrete*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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To my beloved parents and wife

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# ABSTRACT

Conventional concrete has a number of limitations, such as low flexural strength, low failure strain, susceptibility to frost damage and low resistance to chemicals. These drawbacks are well recognized by the engineer and can usually be allowed for in most applications. In certain situations, these problems can be solved by using materials which contain an organic polymer or resin (commercial polymer) instead of or in conjunction with Portland cement. The aim of this work was to study the properties of concrete containing different percentages of polymer additive and to find the optimum polymer additive percentage at fresh and hardened states. The polymer was added accordingly with the percentage of 1 %, 2%, 3%, 5% and 10% by weight of cement. Concrete cubes, cylindrical and beams were tested for compressive strength, tensile strength and flexural strength at the age of 7, 28and 60 days. The results showed that increasing amount of polymer more than 2% decrease workability, compressive strength, indirect tensile strength and flexural strength of concrete 2% polymer mixture showed better result than other percentage and even better than control mix in flexural strength. SEM result shows that adding more than 2% polymer in concrete increase porosity and hence decrease compressive strength of concrete in. Because of relatively good result in flexural strength and brittleness parameter, it is postulated that this material can be used for overlay structure or pavement.

# Abstrak

Beton konvensional mempunyai beberapa keterbatasan, seperti kekuatan lentur rendah, kegagalan rendah ketegangan, kerentanan terhadap kerosakan dan rendah embun beku tahan terhadap bahan kimia. Baik kekurangan ini diakui oleh para jurutera dan biasanya boleh dibenarkan untuk di sebahagian besar aplikasi. Dalam situasi tertentu, masalah ini boleh diselesaikan dengan menggunakan bahan-bahan yang mengandungi polimer organik atau resin (polimer komersial) sebagai pengganti atau bersama dengan simen Portland. Objektif pekerjaan ini adalah untuk mengkaji sifat-sifat konkrit yang mengandungi peratusan yang berbeza aditif polimer dan mendapati peratusan aditif polimer optimum di negara bahagian segar dan mengeras. Polimer ditambah sesuai dengan peratusan 1%, 2%, 3%, 5% dan 10% daripada berat simen. Beton kubus, silinder dan balok diuji untuk kekuatan tekan, kekuatan tarik dan kekuatan lentur pada usia 7, 28and 60 hari. Keputusan kajian menunjukkan bahawa peningkatan jumlah polimer lebih daripada 2% penurunan kemungkinan untuk dilaksanakan, kekuatan tekan, kekuatan tarik tak langsung dan kekuatan lentur konkrit 2% polimer campuran menunjukkan keputusan yang lebih baik daripada peratusan lain dan bahkan lebih baik daripada kawalan campur dalam kekuatan lentur. Keputusan SEM menunjukkan bahawa menambah lebih daripada 2% konkrit polimer dalam meningkatkan porositas dan dengan demikian mengurangkan kekuatan tekan beton masuk Kerana keputusan relatif baik dalam kekuatan dan kerapuhan dilentur parameter, maka mendalilkan bahawa bahan ini boleh digunakan untuk paparan struktur atau trotoar.

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Portland cement concrete is composed of three basic components: Portland cement, aggregates, and water. Mortar and concrete made with Portland cement has been a popular construction material in the world for the past 170 years or more (Ohama, 1995). In addition, there are a host of other materials, called additives that may be added to obtain special properties. These include air entraining agents, accelerators, retarders, carbon black, fly ash, pozzolans, silica fume, water-reducing agents, polymer and super plasticizers, among others.

Conventional Portland cement concrete has a number of limitations, such as low flexural strength, low failure strain, susceptibility to frost damage and low resistance to chemicals. These drawbacks are well recognized by the engineer and can usually be allowed for in most applications. In certain situations, these problems can be solved by using materials which contain an organic polymer or resin (commercial polymer) instead of or in conjunction with Portland cement. These relatively new materials offer the advantages of higher strength, improved durability and good resistance to corrosion, reduced water permeability and greater resistance to damage from freeze-thaw cycles.

One such attempt is polymer-modified (or polymer cement) mortar or concrete, which is made by modifying ordinary cement mortar or concrete with

polymer additives such as latexes, dispersible polymer powders, water-soluble polymers, liquid resins, and monomers. Polymer-modified mortars and concretes have a monolithic co-matrix in which the organic polymer matrix and the cement gel matrix are homogenized.

It was used one kind of waste water- soluble polymer and adding to the concrete with several percentage of cement.

Currently, polymers are used primarily to enhance the durability of concrete. This can be done in four ways (Ohama, 1995):

i) Protective coating and sealants, which are applied on concrete surface, to prevent the ingress of moisture and harmful chemical

ii) Adhesives for bonding in repair and structural joints

iii) Impregnation of hardened concrete with a monomer followed by in situ polymerazation(*polymer-impregnated concrete*)

iv) Incorporation of polymer into the concrete mix(*polymer-modified concrete*)

## 1.2 Importance of research

Concrete is a famous construction material in the world. Meanwhile, continuous efforts towards improving concrete are still underway. Strength and durability are the most important properties normally targeted for improvements.

Although concrete is strong and durable, but it has a lot of defects, for instance low flexural strength, low tensile strength, low resistance to chemical attack as well as freeze-thaw.

Concrete products used in the renovation and refurbishing structure provide a durable hard wearing surface or decorative finish which serve as typical key properties. Today, polymer-based materials or polymer-containing cementitious materials have been utilized in many industrial and non industrial buildings.

## 1.3 Objective of Study

This study was conducted to perform some defined in advance objectives. These objectives are:

i) To study the properties of concrete in fresh state containing different percentages of polymer additive and to identify the optimum polymer additive percentage by conducting, consistency and workability.

ii) To investigate the effect of polymer additive to the strength performance and durability performance of polymer-modified concrete. Parameters assessed were Compressive strength, Tensile strength, Flexural strength, Drying shrinkage, SEM and TGA.

## 1.4 Scope of Research

The scope of research for this project involves the discussion of the effect of polymer additive strength of concrete. Strength characteristic is important because it is related to several other important properties which are more difficult to measure directly

This study concentrates mainly on the strength and durability of concrete. With regard to this matter, the improvement of compression strength of polymer concrete was studied. Addition of polymer by 1%, 2%, 3%, 5% and 10% by weight of cement were studied on compressive, tensile and flexural performance. Concrete tests are conducted on the concrete samples at the specific ages. All the strength tests are limited to the ages of 7, 28 and 60 days.

## 1.5 Thesis layout

This study consists of 5 chapters. Following chapter 1 the concise information on a available literature of polymer modified concrete is presented in chapter 2.chapter 3 the adoptive methodology used in this thesis, containing design of mix proportion and likewise preparation and casting of test samples and detail of testing method. Result are presented in chapter 4 which consisted of result of normal consistency ,setting time ,slump, compacting factor, compressive and tensile and flexural strength, drying shrinkage ,TGA ,SEM (Durability tests) of concrete. Finally in chapter 5 will be presented conclusion and recommendation for current and future experimental work.