



Faculty of Engineering

PROPERTIES OF EPOXY CONCRETE

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Bachelor of Engineering with Honours
(Civil Engineering)
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PROPERTIES OF EPOXY CONCRETE

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ABSTRAK

Projek ini melaporkan keputusan eksperimen penyelidikan keatas sifat konkrit *epoxy*. *Epoxy* digunakan sebagai bahan pengganti simen di dalam konkrit. Sebanyak 72 sampel telah disediakan untuk menyelidik sifat dan ketahanan *epoxy concrete* di dalam atmosfera Malaysia. Penyelidikan adalah termasuk kekuatan mampatan, penyerapan air, seranagan air laut dan ketahanan terhadap suhu tinggi. Di dalam penyelidikan ini, beberapa sampel di rendam di dalam air laut dan dibandingkan dengan sampel yang direndam dengan air paip. Didapati, sampel yang direndam di dalam air laut mempunyai kekuatan mampatan yang lebih rendah. Faktor utama yang mempengaruhi sifa-sifat *epoxy concrete* adalah kandungan *epoxy* di dalam campuran konkrit

ABSTRACT

This project reports the results of an experimental investigation into the properties of hardened epoxy concrete. Epoxy is used as the cement replacement material in the concrete. A total of 108 samples were prepared for this study. The main purpose of this project is to study the properties and durability of epoxy concrete. The studies are including the compressive strength, water absorption, seawater attack and heat test. In this study, the samples were tested in sea water and compared with samples tested in tap water. It was found that the samples that have low compressive strength have high water absorption. The properties of the epoxy concrete are mainly influenced by the content of epoxy in the mix. In the heat test, it was shown that the compressive strength reduces for the sample with 5%, 10% epoxy and the control mix (0% epoxy) as the heating temperature increases. However, for 15%, 20% and 50% epoxy, the compressive strength increases after 400°C temperature (upon cooling).

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LIST OF SYMBOLS

m_1	-	Wet sample weight
m_2	-	Dry sample weight
μ	-	Micro
$^{\circ}\text{C}$	-	Degree of Celsius
$\%$	-	Percentage

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CHAPTER 1

INTRODUCTION

1.1 Background

The nature of this study is basically to do further investigation on the properties of epoxy concrete. Several laboratory testing were conducted to study its properties such as its durability towards water absorption and sea water attack. Besides that, compressive strength and heat resistance of the epoxy concrete were also studied. Epoxy that was used in this project is SIKADUR 52.

1.2 General

Generally, concrete is a construction material consisting of cement (commonly Portland cement), aggregates (usually a coarse aggregate such as limestone with some mixture of sand), water. Portland cement obtained its name when it first used in the early nineteenth century in England, because its products resembled building stone from the isle of Portland at coast British. However, concrete also sometimes composed of some cementitious such as fly ash and silica fume. Adhesive or bonding agent such as epoxy may be added in to concrete paste as a bonding agent in concrete.

Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, architectural structures, foundations, and motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates, fences and poles.

The advantages of concrete are as follows according to Reinforced Concrete Construction Committee, (RC3);

- Concrete is naturally fire-resistant. Concrete buildings has been research for reduced fire insurance rates up to 60 percent less on fire and extended coverage for warehouses and storage buildings. If fire does occur, concrete walls and partitions effectively divide the building into sections, separating areas and limiting the amount of property damage.
- Today's concrete technologies provide innovative solutions for architectural interest and versatility in design. New coloring admixtures provide attractive, economical alternatives to exterior finishing. And concrete is adaptable to a variety of surface treatments and shapes resulting in structures that set graciously into any environment.
- Generally, compressive strength of concrete is between 2000 – 8000 psi, and the tensile strength is between 200-800 psi. Factors, partially or fully independent of the water cement ratio which can affect the strength are

composition and fineness of cement, amount of pozzolan, surface texture and shape of the aggregate, aggregate grading and the improvement of strength by admixtures that can reduce the water-cement ratio.

1.3 Epoxy Concrete

Generally, epoxy resin is one type of polymer-based admixtures. It is added with hardener or catalyst and accelerator to cement mortar during mixing. Epoxy concrete is a modified concrete or mortar which some part of cement in concrete or mortar is replaced by epoxy with part of (usually 10 to 15% by volume or weight) of the cement binder.

Although concrete itself has its advantages as a construction material, usage of epoxy in concrete or mortar mix can give better mechanical strength, have better resistance to penetration by water and seawater, and greater resistance to freeze-thaw damage than ordinary concrete. It also has better bonding to steel reinforcing and to old concrete. This use of epoxy resin is relatively new, but is growing.

Epoxy compounds are generally formulated in two or more parts. Part A is most often the portion containing the epoxy resin and Part B is its hardener system. Epoxy must be formulated to specify the need and functions of each type of epoxy.

However, the use of epoxy resins in preparing concrete research has been difficult for several reasons. Firstly, there are several precaution employed essentially liquid or epoxy resin and room temperature curing agents. The pot life or working life of the composition was limited, as the mixture tends to begin setting up

when epoxy resin curing agent (hardener) and the liquid epoxy resin (resin) mix together.

1.4 Problem Statement

Concrete deterioration due to the environment condition and rusting of reinforcement has received much attention in many years. The conditions that may affect the properties and durability of concrete during their lifetime can be due to: repeated loading, aqueous environment (i.e. high atmospheric humidity, seawater, rain water, and acid rain), changes in temperatures, exposure to freeze–thaw cycles, deteriorating chemicals and alkaline environment in the proximity of Portland cement concrete.

Cracks in concrete have always give a big threat to the durability of concrete. The cracks on concrete depend on the structure, as well as the nature of the cracking for example, structures that acceptable for building not necessary suitable for under water or water retaining structures. There are some causes that lead to the cracks on the concrete structure. Cracking on the hardened concrete are due to the followings:

- Drying shrinkage
- Thermal stresses
- Chemical Reaction
- Weathering
- Corrosion of reinforcement
- Poor construction practices

- Construction overload
- Errors in design and detailing

Prior to the use of epoxy compounds and their versatility and wide range of available physical and chemical properties of epoxy resin systems, epoxy has been found to have a wide variety of uses in the concrete industry. Used of Epoxy resin is one of the alternatives to increase the durability of concrete.

Therefore, some studies have to be developed to determine the advantages of the epoxy especially to the construction industries.

1.5 Objectives of Studies

In this study, 60 concrete cubes of epoxy concrete which contain 5%,10%,15%, 20% and 50% of epoxy compound, and 12 ordinary mortar cubes as control mix were tested to find their properties. The main objectives of this study are:

- To determine the durability of epoxy resin in mortar in various types of exposure condition such as the seawater attack and water absorption
- To determine the strength of epoxy concrete at 28 days.
- To determine the resistance and properties of the epoxy concrete under heat testing.
- To determine the optimum mix design for 5%, 10%, 15%, 20% epoxy resin by weight or volume of cement in mortar mixture.

1.6 Scope of Studies

For this study, the tests that had been carried out are basically to determine the properties of epoxy concrete (since not much work has been done in this area). Epoxy was used as a cement replacing material. The tests were compressive strength, water absorption, seawater attack and heat test only.

Besides that, the materials that had been used for this study were the ordinary Portland cement, fine aggregate (sand) and epoxy.

1.7 Thesis outline

This project report is written into 5 chapters.

- Chapter (1) is the brief introduction of epoxy concrete including the problem statement, objectives, and the scope of works of the project.
- Chapter (2) had been titled the literature review. In this chapter, brief history and background of epoxy concrete also had been written. Some works and studies that have been done by other researchers on epoxy concrete are concluded.
- Chapter (3) was explained the research methodology of the experimental programs. The materials used and mix proportions were also been shown in this chapter.

- Chapter (4) was for the analysis and discussion of the result obtained. The result for every test had been analyzed and discussed in this chapter.
- Chapter (5) is the last chapter which included the conclusion of the studies, recommendation and the limitation of this project.

1.8 Conclusion

At the moment, there were not many researches and studies had been done on epoxy concrete where epoxy was used as the cement replacing material. Therefore, this studied was carried out to investigate the epoxy concrete's properties such its compressive strength, water absorption, seawater attack and heat test.