

POLYMER IMPREGNATION OF POROUS STONES



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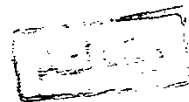
NABAWIA ALI ABDEL FATAH MOUSA

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وَقُلْ اَعْمَلُوا قَسْرِي اِنَّكُمْ وَرَسُولَهُ وَالْمُؤْمِنُونَ
سَعْدَقَ اللهُ الْعَظِيمُ



POLYMER IMPREGNATION OF POROUS STONES

THESIS ADVISORS

APPROVED

Prof . Dr. R. SH. Mikhail

Prof. Dr. S.A. Selim

.

Prof. Dr. A.M. Mousa

.

Prof. Dr. N.M. Guindy

Head of Chemistry Department

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CHAPTER 1

**INTRODUCTION AND OBJECT
OF INVESTIGATION**

CHAPTER I

I.A. Introduction

The attention paid to the impregnation of solid materials commenced in the last few decades and was mainly directed to its application to concrete and cement materials. Its application to other solids attracted less attention whereas its use as a preservative for stones and monuments is only recently applied. Accordingly, a short survey will first be given about cement - concrete impregnation, as it is expected to result in changes of some physical parameters which may as well occur with other solids as limestones.

I. B. Progress and applications of polymer impregnated systems.

After 21 years of research and developing work⁽¹⁾, concrete polymer materials are beginning to emerge from the laboratory into the field as a material of construction with worldwide potential. The first sample of polymer-impregnated concrete was produced at Brookhaven National Laboratory (BNL) in the fall of 1965. Since 1967, BNL has developed the monomer-material formulation and the method of impregnation, measured the structural and durability properties, and initiated development of practical applications. The basic patent on polymer-impregnated concrete was obtained by BNL and is assigned to the U.S. Atomic Energy commission which supported the work.

Initially, the impregnated material was produced by radiation - polymerization. However the thermal-chemical means of initiation is more economical and readily applied.

The results obtained are summarized in a number of publications, notably five topical reports⁽²⁻⁶⁾ that review in detail the information gained and progress made in this work. Lectures and papers on concrete-polymers have been presented at local and national scientific , engineering, and trade societies.

Polymer impregnated concrete (PIC), basically a concrete material, is of interest because of its greatly improved structural and durability properties compared with those of ordinary concrete. PIC has attracted the attention of concrete workers and companies around the world, and much development for applications has been initiated both nationally and internationally.

In the U.S.A. and specifically at BNL, programs have been instituted on construction of new precast bridge decks for highway applications and on impregnation of cast-in-place new and old concrete for the purpose of preventing deterioration of recently placed concrete,

and repairing concrete that has already deteriorated on older bridge decks. Systematic studies were also carried out to develop chemically resistant PIC for operation at elevated temperatures in multistage distillation vessels in large sea-water desalting plants. The studies were extended to include the improvement of the structural stability of roof and wall structures in mines. The American Concrete Pipe Association has also initiated work on PIC pipes for the purpose of producing strong and more durable pipes and thus eliminating the need for costly steel reinforcing. The United States Board of Research (USBR) aimed at producing and testing PIC for tunnel linings for water carriers. The interest in other items such as building blocks, railroad ties, beams, and ferrocement boats continues unabated.

In other countries of the world, interest has been high, and applications have been numerous. The Japanese have built a pilot plant and have produced and used PIC for furniture, base plants, for pumps in corrosive chemical plants, electric cable covers, heated road panels, and underwater structures. The Norwegians have installed PIC curbing on streets in Oslo. The south Africans have made PIC mirror concrete for bathroom and kitchen basins, tile, PIC pipes. The Soviet Union is developing a number of different forms of polymer-concrete and is beginning to use PIC decorative panels for building facades in Moscow. An Italian cement company (near Rome) has instituted an extensive concrete-

polymer program and is using the material in a structural decorative panel for a high-rise building. England, France and Spain have also independent programs on concrete-polymers. Considering that concrete is one of the oldest materials of construction known for thousands of years, the interest in the development of PIC and its growth is truly remarkable.

Research on concrete-polymer materials has been expanded to include lightweight aggregate PIC, the development of polymer concrete, and the incorporation of urban solid waste in PIC and polymer composites (PC). Glass-polymer composite (GPC) materials are an example of the latter, nonreturnable glass bottles or glass-containing incinerator ash are used as aggregates and are mixed with monomers to produce strong, corrosion-resistance sewer pipes.

A paper polymer composite (ppc) containing wastepaper or newsprint has also been developed. This strong, durable board-like material is suitable for wall board, pallets, and traffic signs. These recycled solid waste materials are of great interest to environmental groups and governmental agencies as a potential means of solving part of the country's solid waste disposal problem.

Natural stones have also been impregnated with polymers. These materials have been shown to be of value in mine roof support systems and in the preservation of modern and ancient art work and monuments.

I-C. Role of polymer impregnation on the properties of concrete.

Polymer impregnated concrete (PIC), one of a series of composite materials, is prepared by impregnating precast concrete with a liquid monomer and polymerizing the resin in situ. The polymer tends to fill the porous void volume of the concrete, which results in significant improvements in strength and durability properties. For a concrete mix that produces specimens with a compressive strength of 35.2 mN/m^2 (5000 psi, 352 KgF/cm^2), shows a compressive strength of 212 mN/m^2 ($> 30,000 \text{ psi}$ $> 2120 \text{ kgF/cm}^2$) after impregnation. Similarly large improvements in other structural and durability properties have also been obtained.

It is known⁽⁷⁾ that the fundamental parameters on which the improved qualities of impregnated concrete, compared with traditional concrete, depend on the degree of impregnation of the concrete itself and the subsequent