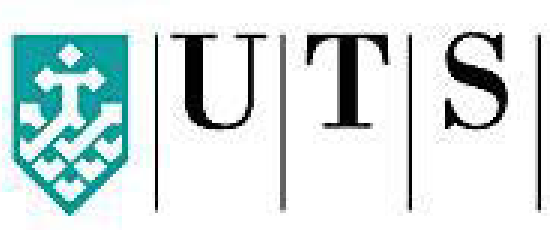

School of Civil and Environmental Engineering

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PERFORMANCE OF POLYMER-CONCRETE COMPOSITES IN SERVICE LIFE OF MARITIME STRUCTURES

By

Seyed Farhad Nabavi

A thesis submitted in fulfillment of the requirements for the degree of

Doctor of Philosophy

December 2014

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I hereby declare that this submission is my own work and to the best of my knowledge it contains no material previously published or written by another neither person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at the University of Technology, Sydney or any other educational institution. Any contribution made to the research by others, with whom I have worked at the University of Technology, Sydney or elsewhere, is explicitly acknowledged in the thesis.

I also certify that the intellectual content of this thesis is the product of my own work. Any assistance that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Seyed Farhad Nabavi

December 2014

ABSTRACT

Premature deterioration of Reinforced Concrete (RC) structures exposed to severe environment has become a global problem with serious economic consequences, environmental impact, and safety issues. According to the enormous investigations, it is evident that the dominant factor of this process is the chloride-induced corrosion of the steel reinforcement in RC structures. Diffusion of the chloride into the concrete occurs through the interconnected pores and surface cracks generated by different sources such as external loading and shrinkage. Large number of the wide cracks not only can accelerate the diffusion process but also enhance the probability of the steel corrosion leading to decreasing the service life of structures. In spite of many conducted studies, records and case studies confirm that the problem still exists.

In this study, current significant corrosion preventing methods have been investigated and their advantages and disadvantages have been examined. Based on this investigation, modifying and improving the microstructure of the concrete, to reduce its permeability, gives the impression to be the most leading method due to easy implementation and lower cost.

In the experimental program of this research two main research areas consisting (i) effect of polymer-concrete composites on mechanical properties of the concrete, and (ii) effect of polymer-concrete composites on service life of RC structures exposed to severe environmental exposure conditions have been investigated. In addition, two different categories of polymer-concrete composites including synthetic fibres and latex polymer have been selected to investigate their effects on mechanical properties and durability performance of the composites. According to the result of this study, polymer-concrete composites reveal enhancement on the mechanical properties of the concrete such as compressive strength, flexural strength, and tensile strength.

Furthermore, to assess the durability performance of the polymer-concrete composites series of long-term tests (up to 720 days) have been conducted in the concrete laboratory of University of Technology Sydney. In this research, service life of the

RC structure has been taken either as time of corrosion initiation (corrosion free service life) or time of cracking of the concrete cover due to steel corrosion (corrosion time). Chloride content measurement was utilized in this study to find the chloride diffusion rate in polymer-concrete composites exposed to high concentrated chloride solution for 24 months. Results of chloride content tests revealed that the polymer-concrete composites can significantly reduce the chloride diffusion rate in concrete and extend the corrosion-free service life of RC structures. To estimate the corresponding service life to corrosion time, an accelerated electrochemical method was deployed in order to obtain the results in relatively shorter time. The results of corrosion time also confirmed that the polymer-concrete composites can increase the service life of the structure considerably.

Most of the previously proposed models available in the literature, consider the chloride diffusion coefficient as a constant parameter. In this study, a new mathematical model was proposed to determine the chloride diffusion coefficient as a time-dependent parameter. In the proposed model the effects of water cement ratio, cement type, cement content, and coarse aggregate proportion were investigated and included

Finally, finite element analysis by Utilizing ABAQUS has been performed to verify the mathematical model. The results of the computer modeling and long-term experimental program are in reasonably good agreement.

To My Lovely Wife

And

To Soul of My Beloved Mother

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES