University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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"Durability Evaluation of Cement-based Repair Materials Used for Corrosion-damaged Steel-reinforced Concrete Structures"

Department of Mechanical Engineering

Tuesday, April 24, 2018
11:00 A.M.
Engineering Office Wing
Room 230

Supervisory Committee:
Dr. Rishi Gupta, Department of Civil Engineering, University of Victoria (Supervisor)
Dr. Caterina Valeo, Department of Mechanical Engineering, UVic (Member)

External Examiner:
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Dr. Pan Agathoklis, Department of Electrical and Computer Engineering, UVic

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Abstract

Concrete repair materials are being widely used to restore and extend the service life of structures. While most cement-based repair materials are compatible with concrete structures, their durability properties do not attract much attention which it deserves from researchers. Since repair materials can deteriorate like conventional concrete, the search for reliable, long-lasting concrete repair materials is becoming more intensive. Amongst other factors, concrete permeability and chloride diffusivity within concrete are believed to play a major role in determining the durability and success of the repair. These two parameters determine the penetration rate of aggressive substances into concrete and how fast degradation could take place. A number of test methods have been proposed to study these two factors, and the commonly used test methods are water penetration, surface/bulk electrical resistivity, rapid chloride permeability (RCP), and half-cell potential. However, the relationship between each test method including compressive strength has also not been fully understood. So, in this study, we aim for using multiple testing techniques, destructive and non-destructive, to evaluate the durability of concrete repair materials as well as correlating different test methods.

Three types of commercially available cement-based materials are tested and evaluated, and results have indicated that cementitious concrete mortar (termed as Mix M) amongst others has the best durability performance which means low water permeability, high resistivity, and compressive strength. Whereas, the flexural performance of Mix M still needs some improvement in terms of flexural strength and flexural toughness. For various durability testing methods, surface resistivity is found to have a strong linear relation and a polynomial relation to bulk resistivity and water permeability respectively. No relationship is established between concrete resistivity and compressive strength, though high-strength concrete tends to have a high resistivity in our study. RCP test results do not correlate well with resistivity measurements, which requires further study to overcome its heating and binding effect when measurements are being taken. Half-cell potential method is used for validating test results but it reveals no difference for materials with different permeability and resistivity.

A model is proposed to counteract temperature effect while calculating the coefficient of diffusion which indicates the concrete to resist chloride diffusion. It is found that this model can shift the RCP measurement slightly closer to its theoretical prediction but the difference between them is still large. Therefore, further research is required for acquiring more raw data from RCP measurements as the regression analysis input. In addition, a more comprehensive model that involves more correction factors for binding effect, etc., is also needed.