COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

"Corrosion Propagation of Reinforcing Steel Embedded in Binary and Ternary Concrete"

November 12, 2020, 2:00 p.m.
Virtual Dissertation

DEPARTMENT:
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ABSTRACT OF DISSERTATION

Corrosion Propagation of Reinforcing Steel Embedded in Binary and Ternary Concrete

The Florida Department of Transportation (FDOT) has been using supplementary cementitious materials while constructing steel reinforced concrete marine bridge structures for over 3 decades. It has been found from previous studies that such additions in concrete mix makes the concrete more durable. This research was conducted to better understand the corrosion propagation stage of steel rebar embedded in high performance concrete exposed to high humidity environment. Reinforced concrete samples that were made with binary mixes, and ternary mixes were considered. None of these concretes had any admixed chloride to start with. An accelerated chloride transport process was used to drive chloride ions into the concrete so that chlorides reached and exceed the chloride threshold at the rebar surface and hence the corrosion process initiated after a short period of time (within few days to few months). Once corrosion has initiated the corrosion propagation can be studied. Electrochemical measurements such as rebar potential measurements, Linear Polarization Resistance (LPR), Electrochemical Impedance Spectroscopy (EIS), and Galvanostatic Pulse (GP) measurements were taken at regular intervals (during and after the electro-migration process) to observe the corrosion propagation in each sample. During the propagation stage, reinforcement eventually reached negative potentials values (i.e., Ecorr≤–0.200 Vsce) for all the samples. The corrected polarization resistance (Rc) was calculated by subtracting the solution resistance from the apparent polarization resistance measured. The Rc values obtained from LPR and GP measurements were converted to corrosion current (as the corroding area is unknown), and these corrosion current values measured over time were used to obtain the calculated mass loss (using Faraday's Law). A comparison was made of the calculated corrosion current obtained using the LPR and GP tests. A comparison of mass loss was also obtained from the values measured from LPR and GP tests. From the experimental results, it was observed that the corrosion current values were largely dependent on the length of solution reservoirs. For specimens cast with single rebar as well as three rebars, the corrosion current values were larger for the rebars that are embedded in samples prepared with a given mix in the order of SL, FA, T1, and T2 respectively. It was also found that the calculated mass loss values were larger for rebars that are embedded in specimens (single rebar and three rebars) prepared with a given mix in the order of SL, FA, T1, and T2 respectively. A variety of corrosion related parameters (Ecorr, Rs, Rc, and Icorr) and calculated theoretical mass loss values observed, were due to the changing parameters such as concrete compositions, concrete cover thickness, rebar diameter, and reservoir size. The specimens showed no visual signs of corrosion such as cracks or corrosion products that reached the concrete surface. It could be speculated that the corrosion products in liquid form penetrated the pore structure without concentrating the bursting force at one location due to the high moisture

condition of the concrete, the products might transport through the concrete pore structure, and as a result no cracks or corrosion bleed outs were observed within the monitored period of approximately 1600 days.

BIOGRAPHICAL SKETCH
Born in Khulna, Bangladesh
B.S., Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh, 2013
M.S., Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh, 2016
M.S., Florida Atlantic University, Boca Raton, Florida, 2017
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CONCERNING PERIOD OF PREPARATION
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Time in Preparation: 2017 – 2020

Qualifying Examination Passed: Fall 2017

Published Papers:

1. Presuel-Moreno, F. J., and Hoque, K. N. 2019. "Corrosion Propagation of Carbon Steel Rebar Embedded in Concrete." *CORROSION 2019*, Nashville, TN.