

Quarterly Progress Report:

Project Number and Title: C3.2018: Condition Assessment of Corroded Prestressed Concrete Bridge Girders

Research Area: Thrust 1: Transportation infrastructure monitoring and assessment for enhanced life

PI: Tzuyang Yu (UMass Lowell)

Co-PI(s): Susan Faraji (UMass Lowell), ChangHoon Lee (WNEU), Moochul Shin (WNEU)

Reporting Period: 07/01/2020 ~ 09/30/2020

Submission Date: 09/30/2020

Overview:

The objective of this project is to assess the condition of corroded prestressed concrete (PC) bridge girders in New England by performing multiphysical field inspection and developing an integrated assessment framework. Table 1 provides our progress on research tasks. Table 2 reports out budget progress. *Due to the impact of covid-19 pandemic in Massachusetts, our laboratory and field tasks were constrained with limited access, in terms of number students/faculty in each laboratory and period of time.* Our experimental tasks had to be improvised in order to continue making progress, as well as to accommodate a financial deficit reality in the second year of Project C.3.

Table 1: Task Progress

Task Number	Start Date	End Date	Percent Complete
Task 1	3/1/19	9/31/19	100%
Task 2	9/1/19	2/28/20	82% (stalled)
Task 3	10/1/19	3/31/20	55% (stalled)

Table 2: Budget Progress

Entire Project Budget	Spend Amount	Spend Percentage to Date
\$89,403 (UML)	\$84,932 (UML)	95%
\$85,000 (WNEU)	\$63,052.86 (WNEU)	74.2%

Table 3: Presentations at Conferences, Workshops, Seminars, and Other Events

Title	Event	Type	Location	Date(s)

Table 4: Publications and Submitted Papers and Reports

Type	Title	Citation	Date	Status
Peer-reviewed journal	Interrelation of Morphological Indices and 2-D Generalized Regularity for Coarse Aggregate in Cement-Based Materials	C. H. Lee, S. J. Lee, M. Shin, and S. Bhattacharya, "Interrelation of Morphological Indices and 2-D Generalized Regularity for Coarse Aggregate in Cement-Based Materials," Construction and Building Materials, 2020, 118984	08/10/2020	Published

Since July 6, 2020, the UML team partially resumed our radar imaging task on campus. From our previous radar imaging result on an intact and an damaged/corroded reinforced concrete (RC) cylinders, we found that there is an angular variation in the radar images of the intact RC cylinder. This was attributed to the non-uniform distribution of coarse aggregates in concrete. Figure 1 illustrates this angular variation of background signal in the radar images of an intact RC cylinder. We also extracted the difference in the radar images of the intact and

damaged RC cylinders, as shown in Figure 2. In Figure 2, the backside of scattering response of a surface crack shows the shape of the background (cylinder), demonstrating the effect of background subtraction.

Under the given condition, the WNEU team was building a corrosion chamber to perform the accelerated corrosion experiment for Task 2, and the corrosion model to calibrate the temperature effect has been simultaneously developed on the basis of the collected data by UML. Figure 3 shows the corrosion chamber at WNEU as work in progress. Figure 4 shows the preliminary resulting ((b), (c), and (d)) current and pH calibrated for the measured temperature (a). The model behind the calibration is based on the physical chemistry, and the postulated activation energy used for the analysis is 60 kJ/mol.

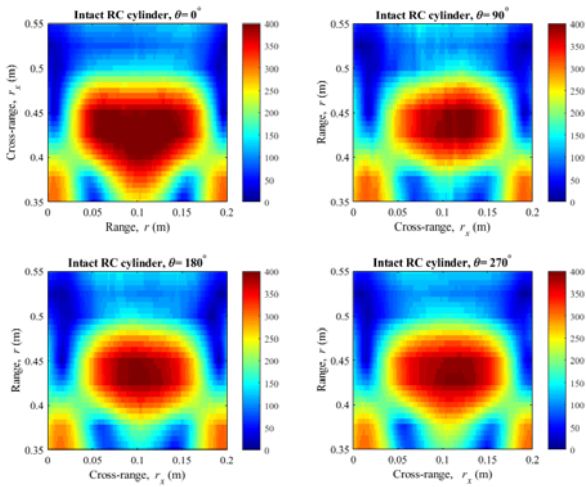


Figure 1: Radar images of intact RC cylinder.

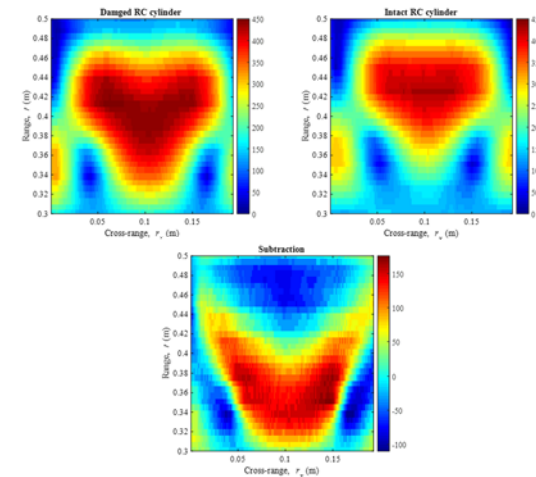


Figure 2: Radar images of intact & damaged RC cylinders.

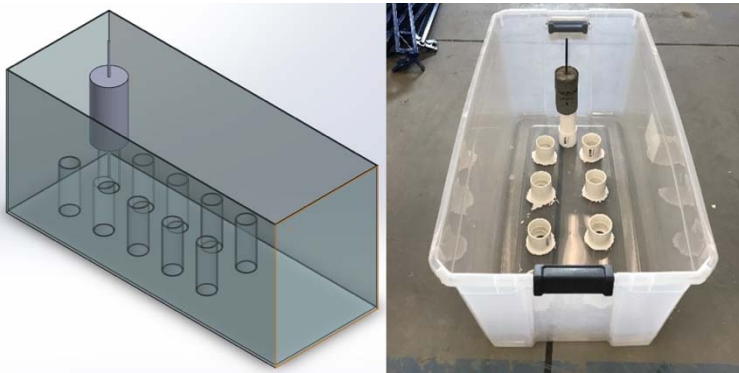


Figure 3: Design and photo of a corrosion chamber at WNEU.

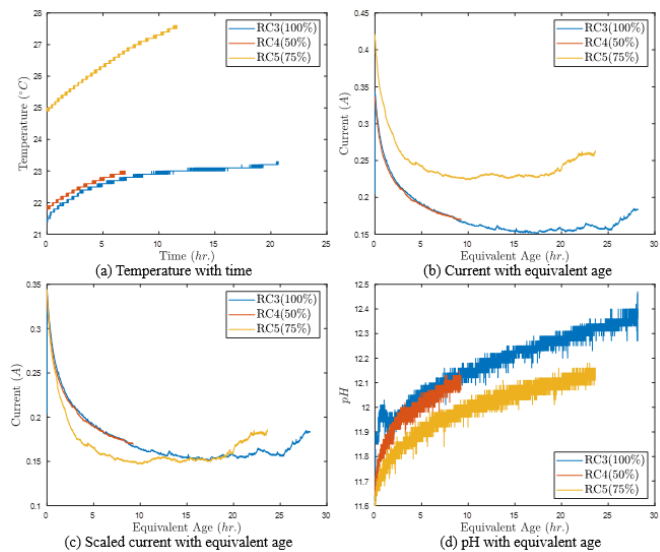


Figure 4: Radar images from two sides of damaged RC cylinder

Participants and Collaborators:

Table 7: Active Principal Investigators, faculty, administrators, and Management Team Members

Individual Name	Email Address	Department	Role in Research
Tzuyang Yu	Tzuyang_Yu@UML.EDU	Civil and Environmental Engineering	Project principle investigator and Institutional Lead at UML; overseeing all projects and working on radar imaging and interpretation

Susan Faraji	Susan_Faraji@UML.EDU	Civil and Environmental Engineering	Structural analysis and design of bridge girders
Chang Hoon Lee	Changhoon.Lee@WNE.EDU	Civil and Environmental Engineering	Development of degradation model and design concrete for pull out test specimen (Task 2)
Moochul Shin	Moochul.Shin@WNE.EDU	Civil and Environmental Engineering	Data analysis of the pull-out test results (Task 2)

Table 8: Student Participants during the reporting period

Student Name	Email Address	Class	Major	Role in research
Sanjana Vinayaka		Ph.D.	Civil and Environmental Engineering	Manufacturing of laboratory specimens, field radar imaging of structures, data analysis and signal processing
Ronan Bates		Junior	Environmental Engineering	Manufacturing of laboratory specimens, laboratory radar imaging
Caleb Tourtelotte		Senior	Civil Engineering	Specimen manufacturing
Nicholas Pantorno		Junior	Civil Engineering	Specimen manufacturing
Cameron Cox		Junior	Civil Engineering	Specimen manufacturing
Andrew Masullo		Junior	Civil Engineering	Specimen manufacturing

Student Name Role in Research Degree Graduation Date

Student Name	Role in Research	Degree	Graduation Date
Ahmed Alzeyadi	Design and manufacturing of laboratory specimens, field radar imaging of structures, data analysis and signal processing	Ph.D.	August 4, 2020

Contribution to the Project

Organization	Location	Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
Massachusetts Department of Transportation (MassDOT)	Boston, Massachusetts				X	X
City of Lowell	Lowell, Massachusetts			X	X	X

Changes:

At UML, our request for return to campus was accepted on July 6, 2020 but with only two students allowed during 7AM and 1PM on Monday, Wednesday, and Friday in one laboratory (SO130) and Tuesday and Thursday in

another laboratory (FA104). While working on campus, all researchers are required to wear personal protection equipment (PPE) such as face masks and face shields, as well as maintaining social distancing.

At WNEU, COVID 19 has significantly disrupted the research activities at WNEU in the last quarter. While the university re-opened as resuming face-to-face classes on August 31, 2020, the lab activities with students are still significantly limited by following the social distancing rule.

Planned Activities:

In the next reporting period, we plan to continue working on following tasks.

Task 2: (Meso-to-Macro Level) Development of Macro-Scale Mechanical Damage Model due to corrosion
(WNEU: C.Lee and M. Shin)

Task 3. (System Level) Development of capacity reduction model for PC bridges due to corrosion (all members)