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: 01/01/2020 ~ 03/31/2020
Submission Date: 03/31/2020

Overview:
The objective of this project is to assess the condition of corroded prestressed concrete (PC) bridge girders in New England by performing multiplysical field inspection and developing an integrated assessment framework. Table 1 provides our progress on research tasks. Table 2 reports out budget progress. Table 4 lists two publications developed from the research finding in this project.

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	80%
Task 3	10/1/19	3/31/20	50%

Table 2: Budget Progress

Entire Project Budget	Spend Amount	Spend Percentage to Date
$89,403 (UML)	$69,734.34 (UML)	78%
$85,000 (WNEU)	$62,609.10 (WNEU)	73.5%

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

Title	Event	Type	Location	Date(s)
N/A				

Table 4: Publications and Submitted Papers and Reports

Type	Title	Citation	Date	Status
Peer-reviewed journal	Subsurface characterization of moisture content and the water-to-cement ratio of concrete specimens using synthetic aperture radar imaging	A.Alzeyadi, T. Yu, Journal of Applied Remote Sensing	03/27/2020	Accepted, under revision
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, 2019	12/31/2019	2nd Review

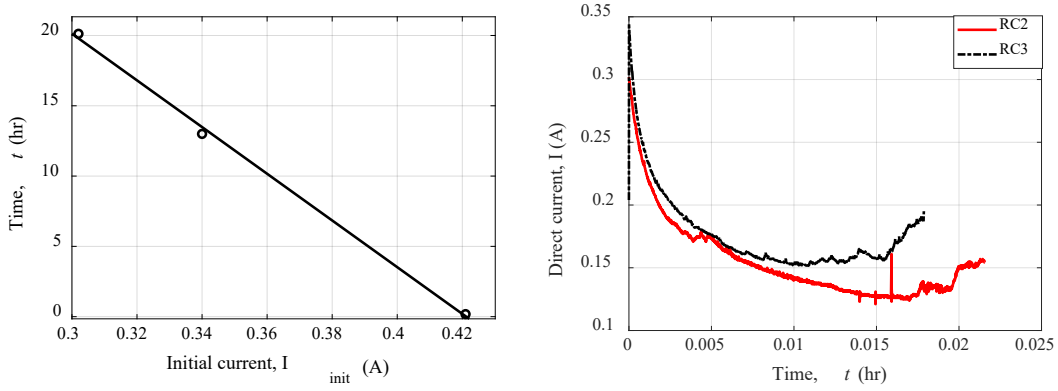
Table 5 lists the six reinforced concrete (RC) cylinders used in this project. Table 6 provides the initial current measurmenets in each articial corrosion test. Figure 1 shows the experimental relationship between initial current and the corrosion time for three RC cylinders, as well as time-dependent current measurements for specimens RC2 and RC3. Figure 2 shows the modeling of average current measurement from specimns RC2 and RC3. We also monitored the environmental condition (e.g., temperature and pH value) inside the corrosion reactor during the course of each artificial corrosion test. Figure 3 compares the pH value and temerature measuremenrts for specimns RC3 and RC4. Our pull-out test apprratus and result are shown in Figures 4 and 5, respectively.

Table 5: List of reinforced concrete cylinders

Specimen	Corrosion level (%)	Note
RC0	0	Reference specimen
RC2	100	**Corroded** until the formation of a major cracked; current, temperature and pH values were recorded during artificial corrosion.
RC3	100	
RC4	50	Corroded for a given duration; current, temperature, and pH values were recorded during artificial corrosion.
RC5	75	
RC6	25	

Table 6: Initial current measurement with time to be corroded of RC cylinders

Specimen	Initial current, I_{init} (A)	Time, t_{corr} to be 100% corroded (hr)	Corrosion level (%)
RC2	0.3020	20.12	100
RC3	0.3440	13	100
RC4	0.3360	14.1504	50
RC5	0.4210	5.18	75



(a) Initial current vs. minimum corrosion time (b) Current measuremenrs for spceimens RC2 and RC3

Figure 1.

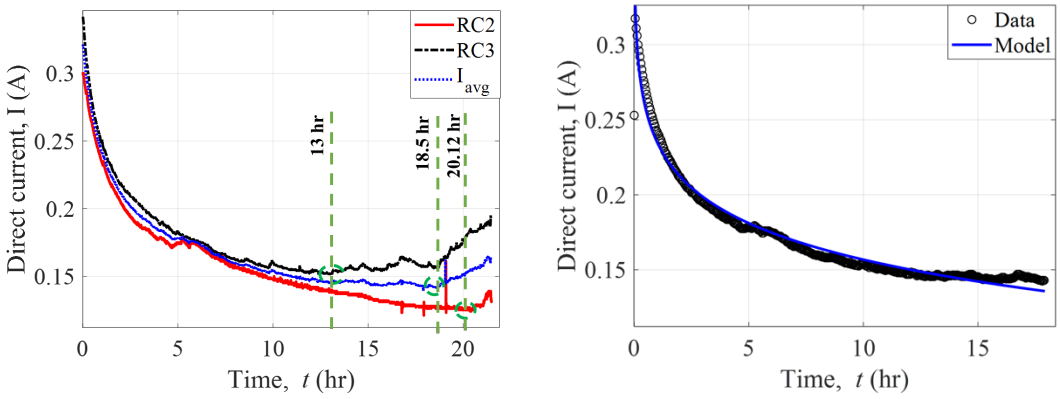


Figure 2: Average of current measurements of specimens RC2 and RC3

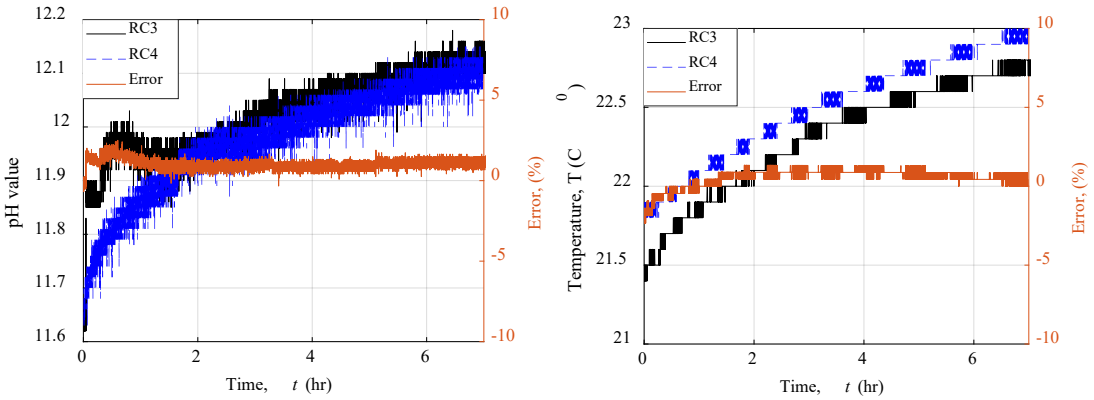


Figure 3: Comparison between the pH value and temperature measurements of specimens RC3 and RC4

Figure 4: Pull-Out UHPC specimens with un-corroded bar.

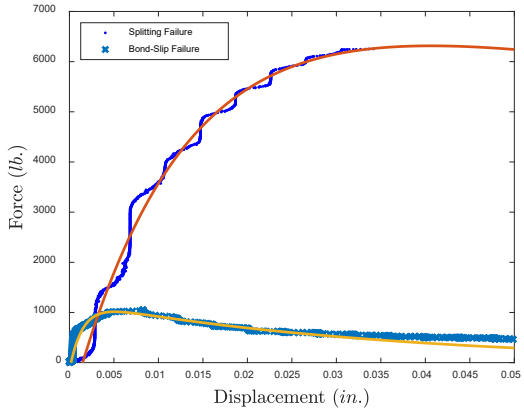


Figure 5: Pull-out force and displacement response

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**
Ahmed Alzeyadi		Ph.D.	Civil and Environmental Engineering	Design and manufacturing of laboratory specimens, field radar imaging of structures, data analysis and signal processing
Sanjana Vinayaka		Ph.D.	Civil and Environmental Engineering	Manufacturing of laboratory specimens, field radar imaging of structures, data analysis and signal processing

Jade Man		Sophomore	Civil and Environmental Engineering	Manufacturing of laboratory specimens
Ronan Bates		Junior	Civil and 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

Table 9: Student Graduates

Student Name	Role in Research	Degree	Graduation Date
N/A			

Table 10: Research Project Collaborators during the reporting period

Organization	Location	Contribution to the Project				
		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:

The recent rapid development of coronavirus and consequent restrictions from the Massachusetts State government and the University regarding group meetings and laboratory access on campus, we have to develop various approaches to continue conducting research with restricted access to our research facilities. Task 2 has been delayed due to the outbreak of coronavirus in Massachusetts. Nonetheless, we will complete Task 2. We have identified two approaches in the following:

1) Hold daily research meetings via teleconference calls – We have been holding research meetings on Zoom since March 16, 2020 and been making progress via teleconferencing.
2) Transition to numerical simulation – We are also in the process of setting up a server on campus to allow research assistants to remotely conduct simulation-related and data processing research tasks on the project.

We will also monitor this rapidly developing situation on coronavirus in Massachusetts and accommodate restrictions and regulations while continuing our research work on the project.

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)

The WNEU team will continue conducting the pull-out test by collaboration with the UML team.