

# Quarterly Progress Report

**Project Number and Title:** 1.4 Electromagnetic Detection and Identification of Concrete Cracking in Highway Bridges

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

**PI:** Tzuyang Yu (UMass Lowell)

**Co-PI(s):** N/A

**Reporting Period:** 04/01/2021~06/30/2021

**Date:** 06/21/2021

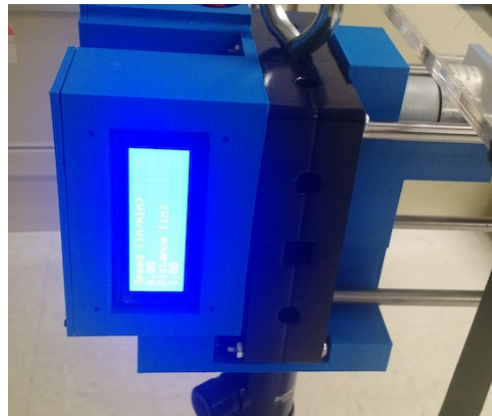
## Overview:

The research problem we are trying to solve is the structural assessment of aging concrete bridges (reinforced and prestressed) in New England, targeting at concrete cracking and degradation. Table 1 provides our progress on individual tasks. Table 2 reports our budget progress.

Table 1: Task Progress			
Task Number	Start Date	End Date	Percent Complete
Task 3	9/1/19	8/31/21	65%
Task 4	9/1/19	9/30/21	89%
Task 5	1/1/20	9/30/21	89%

Table 2: Budget Progress		
Entire Project Budget	Spend Amount	Spend Percentage to Date
\$269,791.11	\$248,207 (estimated)	92% (estimated)

During the last quarter, we have been developing a portable positioner for performing field SAR imaging of highway bridges. This uniaxial portable positioner system is made of two end modules connected by five steel rods and supported by two tripods. Four steel rods are used to stabilize the connection between two end modules. Both end modules are 3D printed by composite materials. One of the end modules is equipped with a rotary motor attached to the fifth steel rod. This fifth steel rod is connected to the fixture supporting a synthetic aperture radar (SAR) unit. The end module equipped with the rotary motor is also installed with a LED screen and a number pad for commanding the fixture to move accordingly. Figure 1 a) shows the entire portable SAR imaging sensor system. Figure 1 b) shows the detail of the LED screen and 1 c) the number pad.



**Fig. 1 a)** Portable positioner system **b)** LED screen

**c)** Number pad

We plan to use the compact, portable SAR imaging sensor system for data collection in the field. At this point, we are testing the performance of the positioner in a laboratory environment for its dynamic stability and speed.

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In the last quarter, we also collaborated with the City of Lowell on the radar inspection of reinforced concrete structures to detect thickness for educational and workforce training purposes, as a service provided to the City of Lowell. A commercial ground penetrating radar (GPR) dual-frequency unit (GSSI UtilityScan, 300MHz and 800MHz) was used in this field data collection. Figure 2 a) shows three UML students working as a team on Main Street, Lowell, MA. Figure 2 b) shows our students measuring the location of GPR for data registration.



**Fig. 2 a)** GPR inspection of concrete slabs

**b)** UML students

We also held two meetings with the director of transportation research program, Dr. Lily Oliver, and bridge inspector, Mr. Gregory Krikoris, from MassDOT on 04/30/21 and 06/16/21. In our 04/30/21 meeting, we presented our progress on the TIDC project and received Greg's comments from his point of view on field practicality. In our 06/16/21 meeting, three highway bridges (Methuen, Lowell, and Chelmsford) were suggested by MassDOT as candidate bridges for our future inspection. Figure 3 shows these three bridges in Massachusetts.



**a)** I-495 bridge in Chelmsford

**b)** Route 3 Lowell Connector in Lowell



**c)** I-93 bridge in Methuen

**Fig. 3** Three highway bridges in Massachusetts for future inspection

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

Title	Event	Type	Location	Date(s)
Subsurface Moisture Determination of Concrete specimens Using Synthetic Aperture Radar Imaging and the K-R-I Transform	ASCE Engineering Mechanics Institute (EMI) 2021 Annual Conference	Conference presentation	Columbia University, New York, NY	May 25, 2021

**Table 4: Publications and Submitted Papers and Reports**

Type	Title	Citation	Date	Status
Journal paper	Electromagnetic detection of concrete cracking by using synthetic aperture radar and ground penetrating radar	NDT&E International	June 22, 2021	Under review
Journal paper	Remote Characterization of Chloride Content in Oven-Dried Concrete Specimens by using Synthetic Aperture Radar Image Models	Construction and Building Materials (CBM)	May 17, 2021	Under revision

**Participants and Collaborators:**

**Table 5: 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

**Table 6: Student Participants during the reporting period**

Student Name	Email Address	Class	Major	Role in research
Tek Dhant		M.S.	Civil and Environmental Engineering	Laboratory radar imaging and data processing
Yaneliz Garcis Ruiz		B.S.	Civil and Environmental Engineering	Assistance in the preparation for bridge field tests
Tiana Robinson		B.S.	Civil and Environmental Engineering	Assistance in the preparation for bridge field tests

**Table 8: Research Project Collaborators during the reporting period**

Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
MassDOT	Boston, Massachusetts				X	X
City of Lowell	Lowell, Massachusetts				X	X
Geophysical Survey Systems, Inc. (GSSI)	Nashua, NH		X	X	X	X

**Changes:**



## **Quarterly Progress Report**



Transportation Infrastructure Durability Center  
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1) Since May 29, 2021, the Commonwealth's mask order is rescinded. The Department of Public Health has issued a new mask advisory consistent with the Centers for Disease Control and Prevention's updated guidance. Masks are still mandatory for all individuals on public and private transportation systems (including rideshares, livery, taxi, ferries, MBTA, Commuter Rail and transportation stations), in healthcare facilities and in other settings hosting vulnerable populations, such as congregate care settings (Source: <https://www.mass.gov/info-details/covid-19-mask-requirements>).

### **Planned Activities:**

In the next reporting period, we plan to continue following research tasks with limited access to our laboratories.

Task 3: Preliminary field radar imaging of concrete bridges

Task 4: Development of EM database

Task 5: Data analysis and image interpretation