Quarterly Progress Report

TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

Project Number and Title: C11 Development of a system-level distributed sensing technique for long-term monitoring of concrete and composite bridges
Research Area: Thrust 1: Transportation infrastructure monitoring and assessment for enhanced life
PI: Tzuyang Yu (UML)
Co-PI(s): Susan Faraji (UML), Xingwei Wang (UML), Zhu Mao (UML), Bill Davids (UMaine), Ehsan Ghazanfari (UVM)
Reporting Period: 04/01/2021~06/30/2021
Date: 06/30/2021

Overview:

The research problem we are trying to solve is the long-term monitoring problem of bridges (e.g., concrete and composite bridges), using multiple modes of sensing technology including fiber optic, video motion, and electromagnetic sensors. In the past quarter, we focused our efforts on i) processing the collected sensor data, ii) planning on next field trip back to Hampden, ME, and iii) identifying other candidate bridges in MA for instrumentation and inspection.

Table 1: Task Progress

Task Number	Start Date	End Date	Percent Complete
Task 1	01/01/20	02/28/20	100%
Task 2	01/01/20	03/31/20	100%
Task 3	01/01/20	07/31/20	100%
Task 4	07/31/20	08/15/20	100%
Task 5	08/15/20	08/20/20	100%
Task 6	08/15/20	12/31/21	40%
Task 7	08/20/20	12/31/21	0%
Task 8	01/01/20	12/31/21	5%

Table 2: Budget Progress

Entire Project Budget	Spend Amount	Spend Percentage to Date
$166,304 (Year 1)	$58,206 (*TBD*)	35% (estimated)

Radar baseline measurements on the Grist Mill Bridge (Hampden, ME) – We used a commercial ground penetrating radar (GPR) system (UtilityScan, GSSI, 300MHz and 800MHz) to develop the electromagnetic/radar baseline data of the bridge in the longitudinal and transverse directions of the bridge. Figure 1 shows the longitudinal GPR B-scan images of girders 3 (path 8-11) and 5 (path 9-12) in 300 MHz and 800 MHz. From Figure 1, we can clearly see the asphalt pavement layer and steel rebars embedded in the concrete bridge deck structure. We also collected the baseline data of the bridge in the transverse direction. Figure 2 shows the shows the transverse GPR B-scan images of the bridge in 300 MHz and 800 MHz.

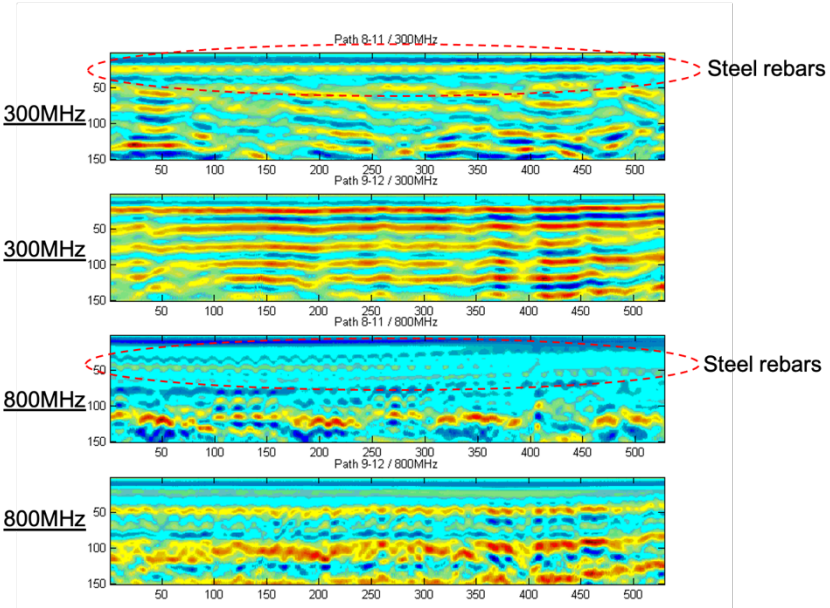

Fig. 1. Longitudinal GPR B-scan of girders 3 and 5

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From the result in Figure 2, we can clearly see the boundaries between concrete bridge deck and sidewalk. The boundaries between two composite girders are not as consistently clear for all five girders. This is because that our transverse GPR scans were conducted at a skewed angle with respect to the girders, rather than in parallel to the girders. We plan to develop transverse GPR scan data in the parallel configuration in our next visit to the bridge.

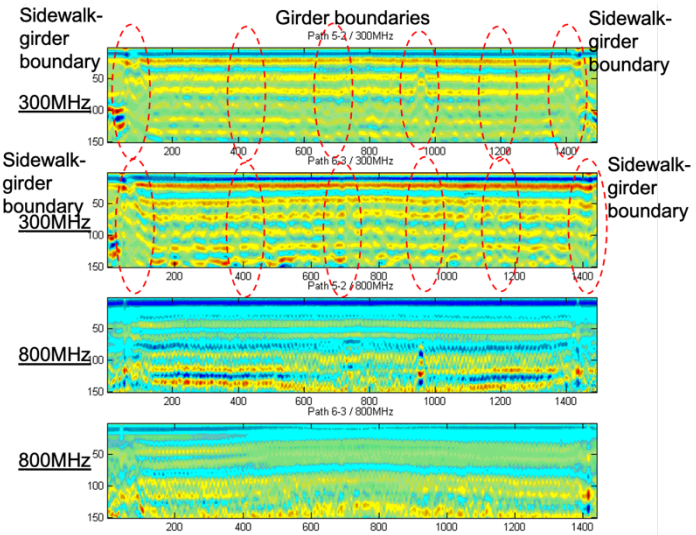

Fig. 2. Transverse GPR B-scan of all girders (from girder 5 to girder 1)

Revisit the Grist Mill Bridge in summer 2021 – We are planning on a revisit to the bridge this summer, in order to develop another baseline dataset at higher temperature. Our current baseline datasets were collected in the range of 28ºF and 34ºF during 12/30/20~12/31/21.

Other candidate bridges in MA – After exchange of emails with the MassDOT, we had our first Zoom meeting with Mr. Greg Krikoris (P.E., Area Bridge Inspector) and Dr. Lily Oliver (Director of Research Program). After presenting our technologies to the MassDOT, three bridges in MA were identified in Figure 3. After submitting our inspection plan to the MassDOT, an approval letter was issued by the MassDOT on June 25. We are now developing detailed inspection and instrumentation procedures for these MA bridges.

a) C-08-026 I-495 Bridge (Chelmsford)

b) L-15-076 Rt. 3 Bridge (Lowell)

c) M-17-017I-93 Bridge (Methuen)

Fig. 3. Candidate bridges in MA for inspection and instrumentation

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**

Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events				
Title	**Event**	**Type**	**Location**	**Date(s)**

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 (PI) and Institutional Lead at UML; overseeing all project activities
Susan Faraji	Susan_Faraji@uml.edu	Civil and Environmental Engineering	Co-PI, bridge design and analysis
Xingwei Wang	Xingwei_Wang@uml.edu	Electrical and Computer Engineering	Co-PI, development of optical sensors
Zhu Mao	Zhu_Mao@uml.edu	Mechanical Engineering	Co-PI, dynamic health monitoring using motion videos
William Davids	William.Davids@maine.edu	Civil and Environmental Engineering	Co-PI, design and analysis of composite bridges
Ehsan Ghazanfari	Ehsan.Ghazanfari@uvm.edu	Civil and Environmental Engineering	Co-PI, data fusion and analysis

Table 6: Student Participants during the reporting period				
Student Name	**Email Address**	**Class**	**Major**	**Role in research**
Harsh Gandhi		Ph.D.	Civil and Environmental Engineering	Manufacturing of laboratory specimens, data analysis and signal processing
Andrew Schanck		Ph.D.	Civil and Environmental Engineering	Finite element model construction and simulation
Rui Wu		Ph.D.	Electrical and Computer Engineering	Manufacturing and testing of optical sensors
Celso Do Cabo		Ph.D.	Mechanical Engineering	Assistance in the preparation for bridge field tests
Lidan Cao		Ph.D.	Electrical and Computer Engineering	Manufacturing and testing of optical sensors
Andres Biondi Vaccarriello		Ph.D.	Electrical and Computer Engineering	Manufacturing and testing of optical sensors

Table 7: Research Project Collaborators during the reporting period						
Organization	**Location**	**Contribution to the Project**				
		Financial Support	**In-Kind Support**	**Facilities**	**Collaborative Research**	**Personnel Exchanges**

AIT bridges	Brewer, Maine		X	X	X	X
Saint-Gobain North America	Northborough, Massachusetts		X	X	X	X
MaineDOT	Maine	X		X	X	X
Geophysical Suevry Systems Inc. (GSSI)	Nashua, New Hampshire				X	X
MassDOT	Boston		X	X	X	X

Changes:

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:

We plan to return to the Grist Mill Bridge in summer (August) to collect the baseline data at higher temperature. We also plan to install sensing textiles on a different bridge in New England.

Task 6: Monitoring of structural performance under service and environmental loads
Task 7: Data fusion, visualization, and interpretation
Task 8: Documentation, reporting, and dissemination