TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): IOWA DOT

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(449)*	**Transportation Pooled Fund Program - Report Period:** Quarter 1 (January 1 – March 31, 2020) Quarter 2 (April 1 – June 30, 2020) Quarter 3 (July 1 – September 30, 2020) X Quarter 4 (October 1 – December 31, 2020)

Project Title: Robust wireless skin sensor networks for long-term fatigue crack monitoring of bridges		
Project Manager: Khyle Clute	**Phone:** 239-1471	**E-mail:** khyle.Clute@iowadot.us
Project Investigator: Simon LaFlamme	**Phone:** 294-3162	**E-mail:** laflamme@iastate.edu

Lead Agency Project ID:	**Other Project ID (i.e., contract #):** Addendum 736	**Project Start Date:** May 15, 2020
Original Project End Date: May 14, 2023	**Contract End Date:** May 14, 2023	**Number of Extensions:**

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Total Percentage of Work Completed
$ 540,000	$42,720.14	15%

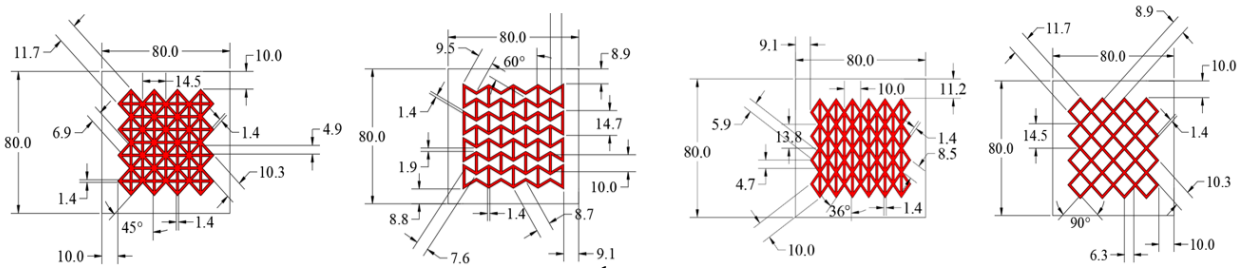
Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$23,820.14		4%

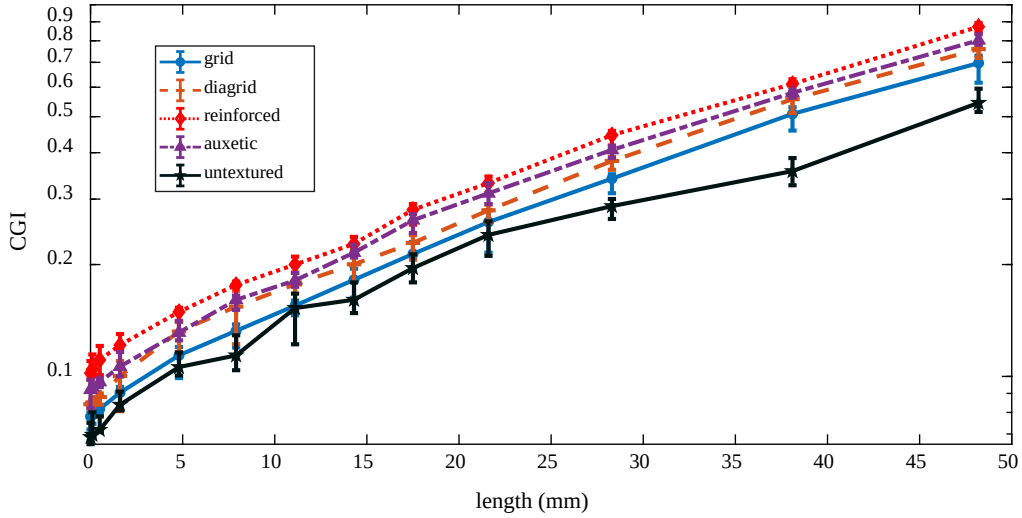
Project Description:

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

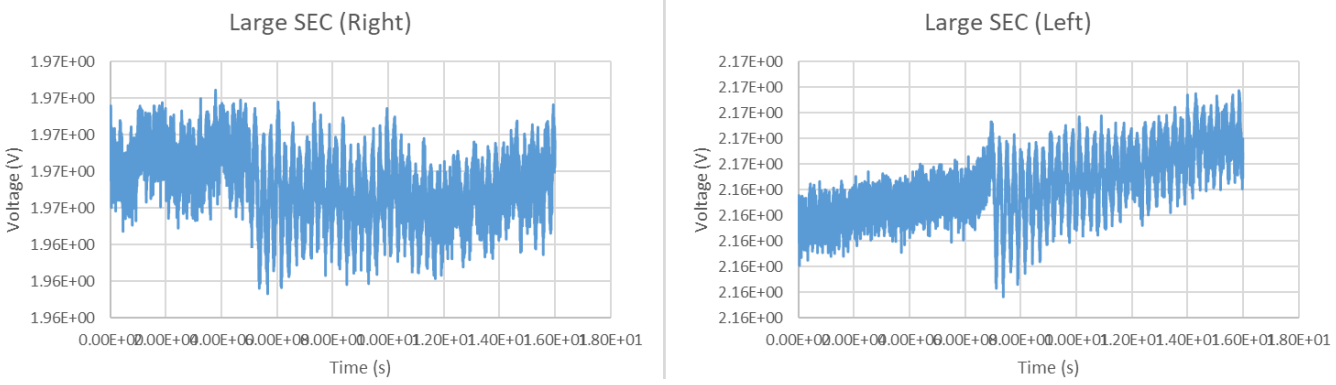
- TAC meeting on Jan 13th 2021.
- ISU fabricated non-textured and textured SEC sensors and shipped to institutional partners.
- ISU tested four different corrugation patterns (shown below).



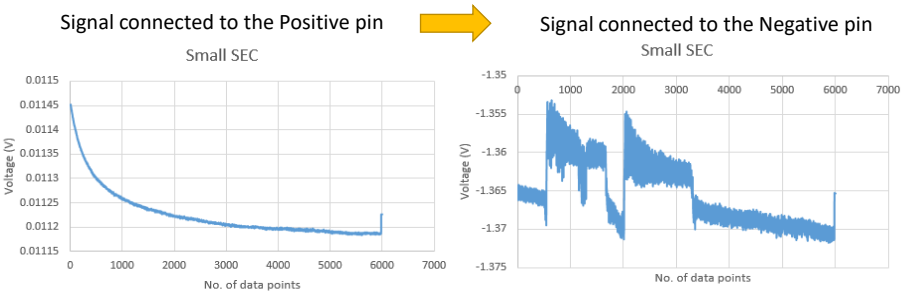
- ISU based on test data, the reinforced pattern (first on left) was selected to move forward and replace the non-textured SEC. This selection was based on the higher linearity of the CGI vs crack length results (figure below) and symmetry of the pattern that results in an easier field deployment.



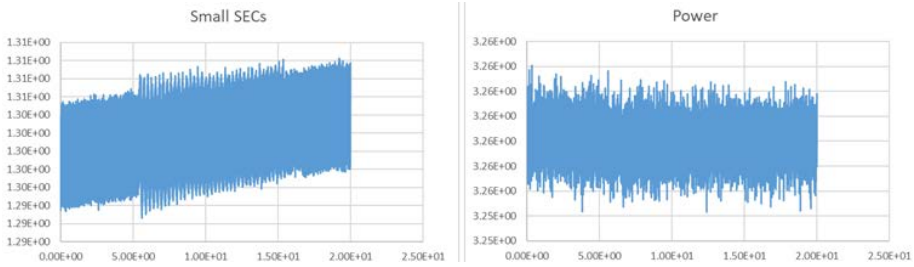
- KU prepared the second specimen to install large SECs in parallel with small ones and balanced the UA board for large SECs for field deployment. The balancing was successfully done as shown below, and NI DAQ was used to record the signals:



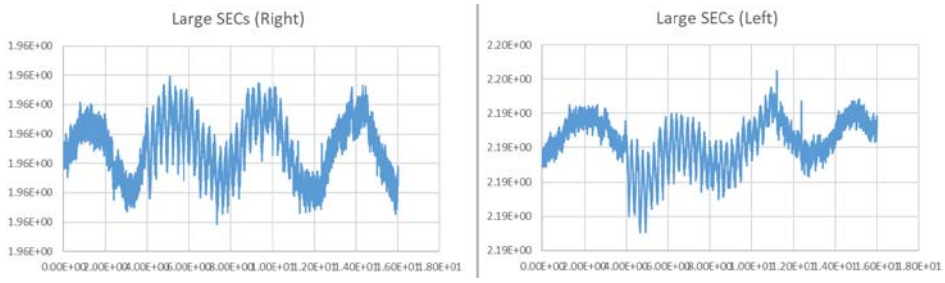
- KU was able to reproduce several issues observed from the previous field deployment, as described below.
- KU identified issue 1 regarding two Xnodes 003 and 004, and solved it by switching to the negative pins of the channels in the Xnodes (shown in Figure below)



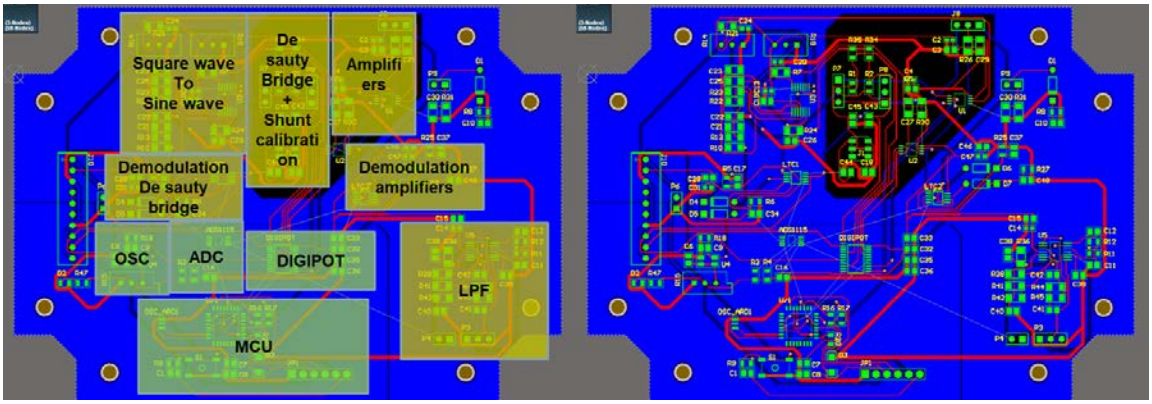
- KU identified issues 2 (linear drift) shown below, which was due to the power of the Xnode. It can be solved through signal processing.



- KU identified issues 3 (long-period signal fluctuation) as shown below. The long-period fluctuation occurred when multiple SEC sensors with their UA boards were connected and powered by one Xnode. The solution is still being investigated.



- UA developed the digital shunt calibration circuit that calibrates the capacitance to voltage value. The FET type switch showed a great performance on this purpose (i.e. ON/OFF the shunt calibration circuit).
- UA tested and confirmed the functionality of each components in a single board setup.
- UA designed a new sensorboard schematic and board layout shown below.



- USC further validated the previously developed analytical model for the out-of-plane deformation with a Finite Element Analysis model.
- USC developed custom test fixtures for the compression testing of concrete beams with controlled surface textures for testing of SEC using a variety of adhesion methods.
- USC integrated a data acquisition system into the existing dynamic testing machine.

- USC started the experimental testing of scaled concrete beams
- USC started the development of an automated test fixture and procedure for the SEC on the concrete beams that will allow for the testing of automated and synchronized testing of SECs on concrete beams.

Anticipated work next quarter:

- ISU will archive tests from C(T) specimens and design tests on complex steel geometries.
- KU will work with UA to address issue 3 (long-period fluctuation in the signal).
- KU will create a third test specimen with multiple SECs instrumented. The goal is to test the wireless autonomous monitoring system before field deployment.
- UA will print the new sensorboard and test the performance
- USC will run a set of tests on the concrete beams with controlled surface textures for testing of SEC using a variety of adhesion methods.
- USC will begin an experimental campaign for crack detection in concrete beams under controlled loading.

Significant Results:

- Selected a new geometric pattern for the sensor.
- Identified the issues to improve future field deployment result using the Gen1 system.
- Designed the digital shunt calibration circuit and new sensorboard.
- Obtained preliminary data on concrete specimens.

Circumstance affecting project or budget (Describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope, and fiscal constraints set forth in the agreement, along with recommended solutions to those problems). N/A