CAAP Quarterly Report

Date of Report: *Sept. 1, 2015*

Contract Number: *DTPH56-13-H-CAAP02*

Prepared for: *DOT*

Project Title: *Scaling and Self-Sensing in Composite Repairs of Corrosion Defects*

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For quarterly period ending: *June 1, 2015*

Business and Activity Section

(a) Generated Commitments

There has been no change in project participants or other contracts.

Supplies	Cost
Testing system supplies	$37.82
Berendsen Fluid Power	$222.57
Testing system supplies	$22.03
Berendsen Fluid Power	$1,120.87
Testing system supplies	$69.83
Milling Inserts	$81.84
Steel Forming Inc Dba	$601.00
Strain Gages	$337.75
Milling Inserts	$100.45

(b) Status Update of Past Quarter Activities

During the last quarterly period we have

1. Repaired fatigue testing system
2. Begun fabrication of large scale test vessel
3. Completed initial self-sensing study
4. Published a journal article related to the coupon specimen developed for the self-sensing study

Small-Scale Sample Testing

During the fatigue testing on the small scale samples a seal ruptured on our fatigue testing system. This rupture caused damage to the hydraulic pump head and shuttle valve requiring a replacement and repair of these items. Due to lead times on parts, we completed the repairs in late august and are now resuming the fatigue test on these specimens.

Large Vessel Fabrication

A schematic drawing of the large scale test specimen is shown below in Figure 1 and indicates weld lines and flaw locations. Two vessel heads were purchased last quarter and have arrived. The flaws have been machined and are scheduled to be welded and rolled in the next week.

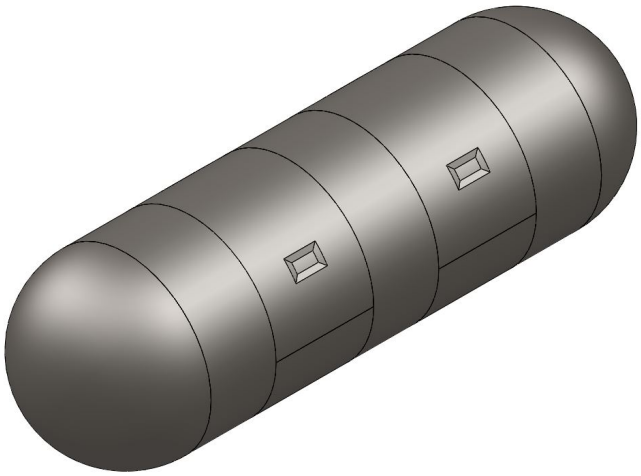

Figure 1: Schematic overview of large-scale (42" diameter) pressure vessel.

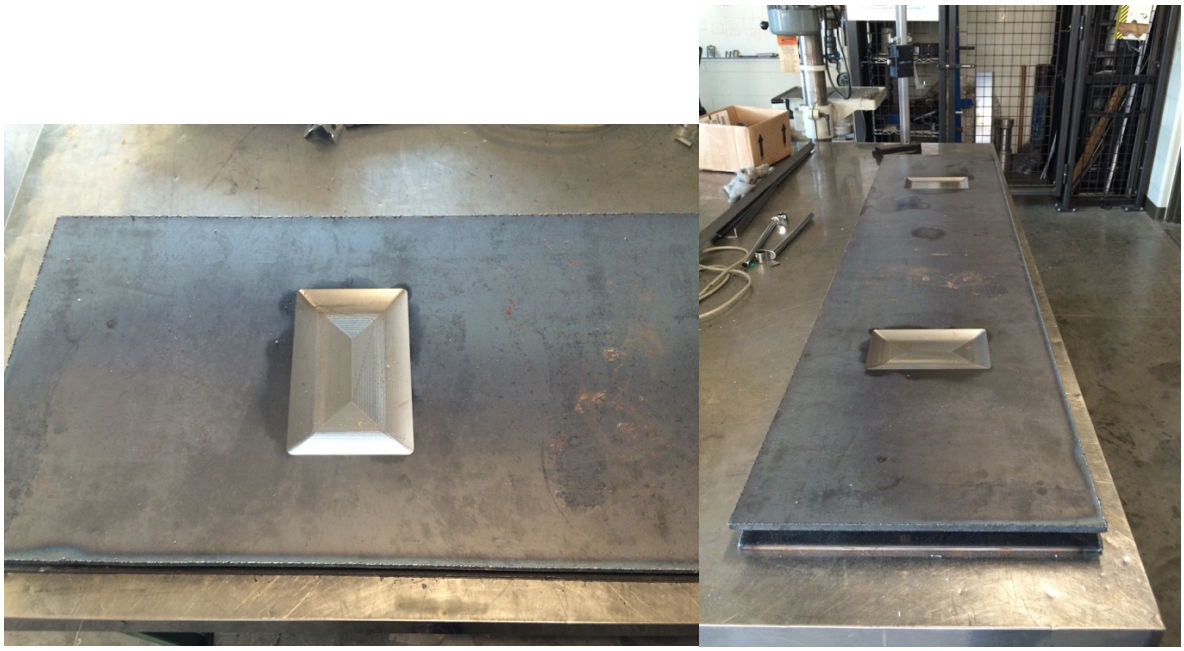

Figure 2: Images of machined flaws in plate prior to rolling and welding

Figure 2 shows the machined flaws in the plate prior to rolling and welding for vessel fabrication. The longitudinal welds will be completed using a subarc system and will be x-ray inspected to ensure complete penetration. The tube section of the pipe will be welded and then re-rolled if necessary. We expect this to be completed within the month.

Self-Sensing Research

In parallel with the fatigue testing we have been working on the self-sensing portion of this research proposal. We have two major accomplishments that were finalized in the last quarter. We have published a journal paper in Engineering Fracture Mechanics describing the performance and validation

of a coupon specimen for the composite-steel interface in repairs. We have also validated the proposed resistance-based monitoring of the interface using this coupon.

Figure 3 shows a voltage measurement performed on a coupon fatigue sample of composite repair material bonded to a steel substrate. This measurement was performed using the validated coupon specimen. To perform the measurement in Figure 3, a potential of 2 V was applied across the specimen as shown in the figure inset. This applied voltage equated to roughly 0.53 mA of current. The voltage is somewhat higher than what would be expected in an impressed current system and we are investigating the impact of the lower voltages on the response of the system. Critically, there is sufficient electrical contact between the carbon composite of this repair system and the steel to make a voltage drop measurement. This is likely not the case for other reinforcement systems, glass or Kevlar, and a modification of the resin would be required to enable this measurement.

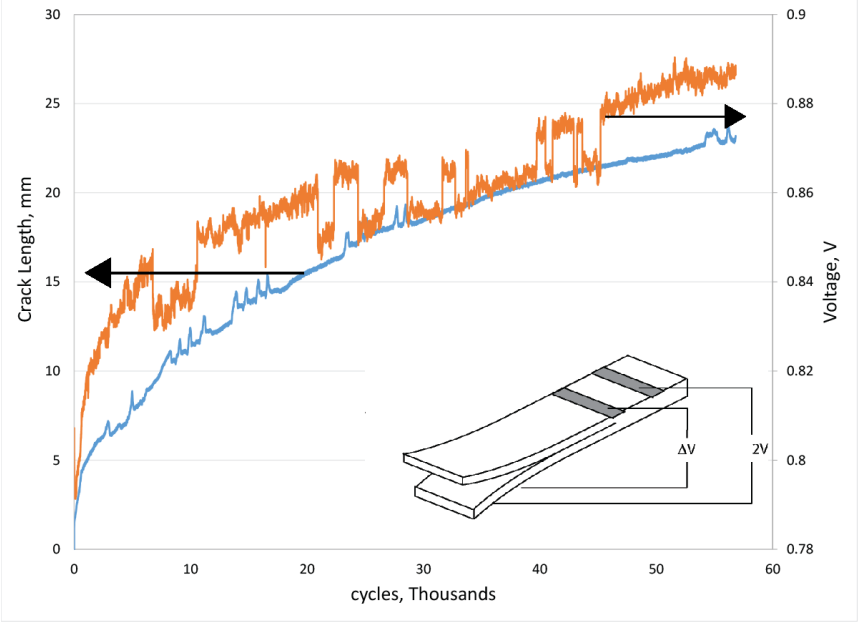

Figure 3: Plot of crack-length vs. cycles for a coupon specimen with an associated voltage measurement. Note agreement between voltage measurement and crack growth.

We are working with an associated project on through-wall repair to validate the use of this approach for monitoring the structural health of an installed repair. We are also working on developing some basic sensing electronics that can, ideally, interface with either surface interrogation or monitoring equipment or be carried by inline inspection devices.

(c) Description of any Problems/Challenges

We are still facing schedule delays for fatigue testing the small-scale pressure vessels. This delay has been exacerbated by the mechanical issues associated with the testing system. There are no other issues at this time. Because of the timing of the graduate student hire, we have requested a no-cost extension for this project. This extension should help ease the scheduling issues.

(d) Planned Activities for the Next Quarter –

Since we are in the testing phase, our planned activities for the next quarter are similar to those of last quarter (ending June 1.)

1. Complete small scale fatigue testing.
2. Complete fabrication of large-scale test vessel and pressure system.
3. Perform an initial on-specimen self-sensing test during the fatigue testing.
4. Begin large-scale specimen installs and testing.