CAAP Quarterly Report

Date of Report: *April 14, 2015*

Contract Number: *DTPH56-14-H-CAP01*

Prepared for: *DOT*

Project Title: *Patch and Full-Encirclement Repairs for Through-Wall Defects*

Prepared by: *The University of Tulsa*

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For quarterly period ending: *April 10, 2015*

Business and Activity Section

(a) Generated Commitments

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

Supplies Purchased	Cost
Pressure Washer	$949.99
Solenoid Vales	$136.17
Piping Supplies	$204.95
Filter	$118.27
General Supplies	$10.00
Pipe	$5,281.20
Sand Blasting	$45.00
General Supplies	$138.56

(b) Status Update of Past Quarter Activities

In the past quarter (starting December 1, 2014), we have completed the following research activities

1. Completed kick-off meeting
2. Continued finite element studies of repair.
3. Fabricated small-scale test pipes.
4. Finalized test plan and schedule some repair installs.
5. Performed initial testing of a repaired pipe to shakedown testing system and determine factor of safety in ASME PCC-2

Small Scale Test Program

As of this progress report, we have purchased and fabricated the small-scale test specimens for the proposed testing program. Six-inch nominal schedule 40 pipe has been cut, machined, and welded and is ready for the industry participants to install repairs. Two companies have already scheduled time to install repairs. Because of the overlap with the corrosion-defect project, we are modifying a pressure-washer based test system to perform the lower-pressure testing of the small-scale pipes. This test system should be operational during the second quarter of 2015 and we should begin fatigue testing of the small-scale pipes.

We have also performed an initial fatigue test on a repaired pipe in order to investigate the in-built factors of safety in PCC-2. From this test we have decided to ask the installers to repair for a design pressure of 500 psi. We will then cycle pressure to the full design pressure. This test pressure was chosen as it is near the MAOP of a 42-inch vessel.

FEA Studies of Through-wall Defects

During this quarter, we continued our FEA investigation of pipes with through-wall defects. Since the geometry is complex and the J-integral and VCCT techniques were not simple to apply, we are investigating opening strains along the interface of the repair as a simple comparison between the patch and full-encirclement repairs. We expect that this information will give us an initial insight as we work on implementing the fracture-mechanics-based computational approaches.

Figure 1 shows a FEA simulation result with a white arrow indicating the interface between the substrate pipe and the composite repair. Strains in the repair were extracted along this line as a stand in for opening forces that tend to drive crack propagation. Figure 2 shows the FEA predicted strains along this interface for a patch and a full encirclement repair. From this data we can see that the patch repair has larger maximum strains when compared to the patch repair. The average strain level is also higher for patch repairs when compared to full encirclements. Based on the deformation of a full-encirclement repair compared to a patch repair, the increase in strain is likely due to increased bending deformation of the base pipe. Increased deformation tends to pull the substrate away from the repair, likely causing the observed increase in opening strains. This result tends to indicate that a patch repair will have relatively poorer performance when compared to the full-encirclement. This has yet to be confirmed with experimental data.

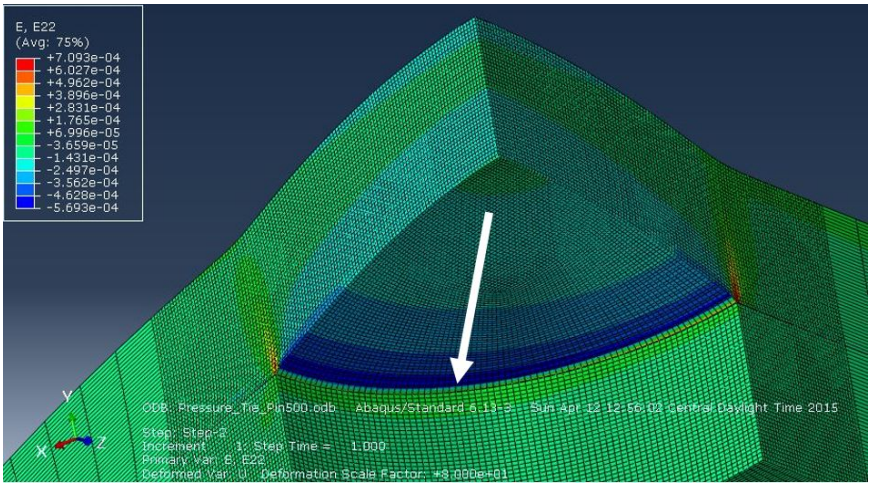

Figure 1: FEA results of a simulation of a composite repair indicating interface that we are currently studying.

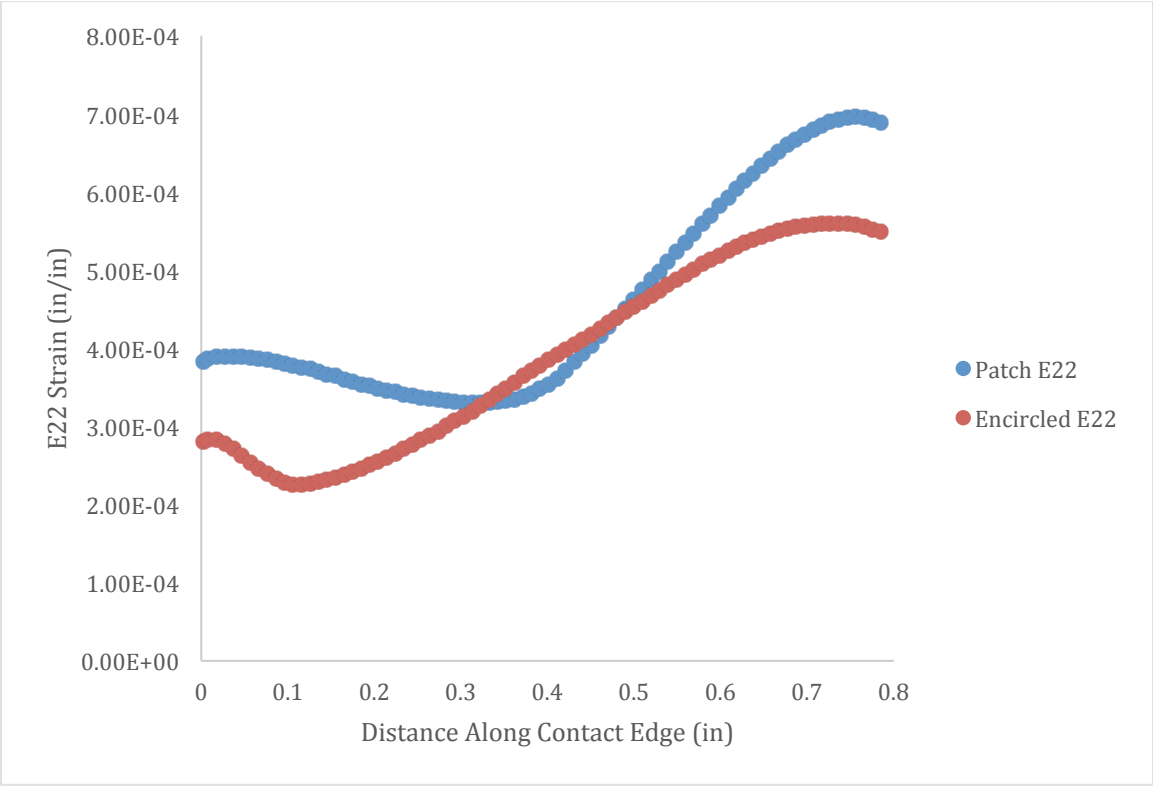

Figure 2: Comparison of a FEA-predicted opening strain (e22) at the location indicated in Figure 1.

(c) Description of any Problems/Challenges

During this past quarter there were no significant challenges. A graduate student, Stephen Theisen, was hired at the beginning of the semester. The only major issue is timing with respect to the pressure fatigue system. The pressure-washer based system should eliminate any major conflicts between the two test programs.

(d) Planned Activities for the Next Quarter –

Planned activities for the next quarter include the following

1. Continue assembly and shakedown of pressure fatigue testing system.
2. Support installs of repairs on small-scale specimens
3. Continue FEA modeling of the repair.