CAAP Annual Report

Date of Report: *January 10, 2016*

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: *January 10, 2016*

Business and Activity Section

(a) Generated Commitments

This section is only for the last quarter. There have been no changes to project or project participants at this time.

Supplies Purchased	Cost
Piping and fittings	$120.17
Strain gage supplies	$347.85

(b) Status Update of Past Quarter Activities

During this past quarter, we have accomplished the following research activities

1. Continued fatigue testing of small scale samples.
2. Began strain gage study of repairs.
3. Initial DIC studies of repairs.
4. Began design and fabrication of large scale specimen.

Small Scale Test Program

All but one set of patch specimen fatigue tests have been completed at this point in the study. Based on the current fatigue life results, there appears to be no significant difference between patch and full-encirclement performance for the small scale specimens. Each manufacturer has taken a different approach for determining repair thickness, and this has lead to different overall repair life. However, the results to date indicate that the repair behavior is consistent within each design approach.

Strain Gage Testing Results

In this last quarter we have begun testing the specimens that were instrumented with strain gages. A schematic of the strain gage locations are shown in Figure 1. Each of the gages in this schematic are biaxial and are installed to measure hoop and axial strains. Initially, we had proposed to install inter-layer strain gages, but decided against that approach after discussions with the participants. There was concern that the fiber disruption caused by the embedded strain gages could have negative impacts on the fatigue life of the repairs.

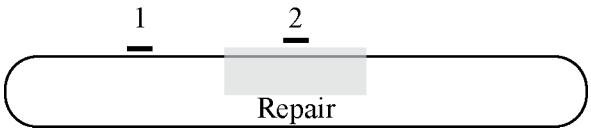

Figure 1: Schematic of strain gage placement on specimens.

A representative set of data from the hoop-oriented gage in location 2 in Figure 1 is shown in Figure 2. The strain reading in this data was not zeroed prior to loading and the low pressure strain values are due mostly to lead-wire effects, which will be removed at a later point. For this repair, which was one of the thickest repairs, the overall strain range is only 0.02% during a loading cycle. This is very low and this specimen went to the runout point of 100,000 cycles. Several of the remaining instrumented samples failed prior to the 100,000 cycles and we expect that both the strain ranges and absolute strain values will be significantly larger.

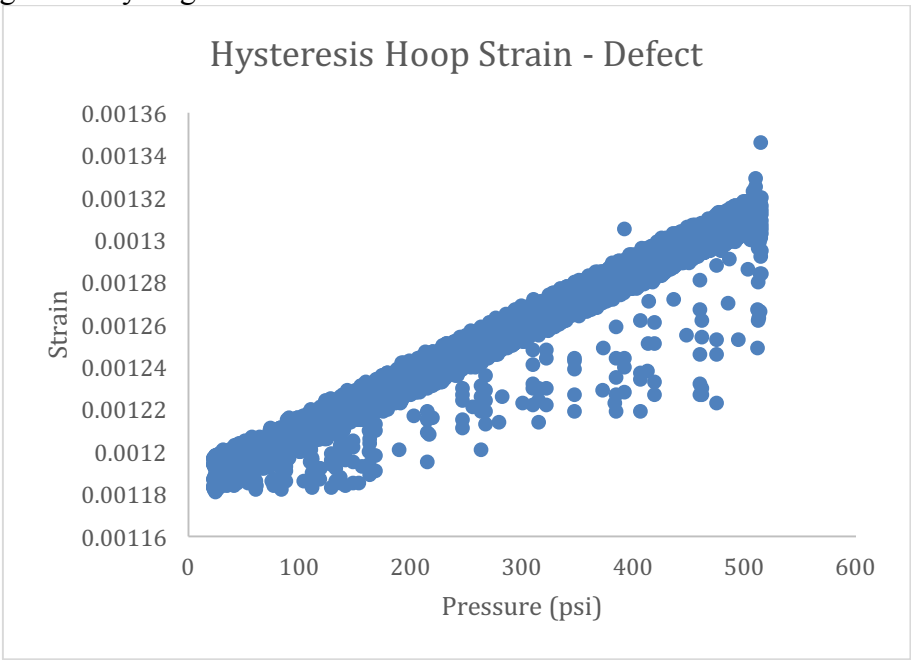

Figure 2: Pressure vs hoop strain over hole.

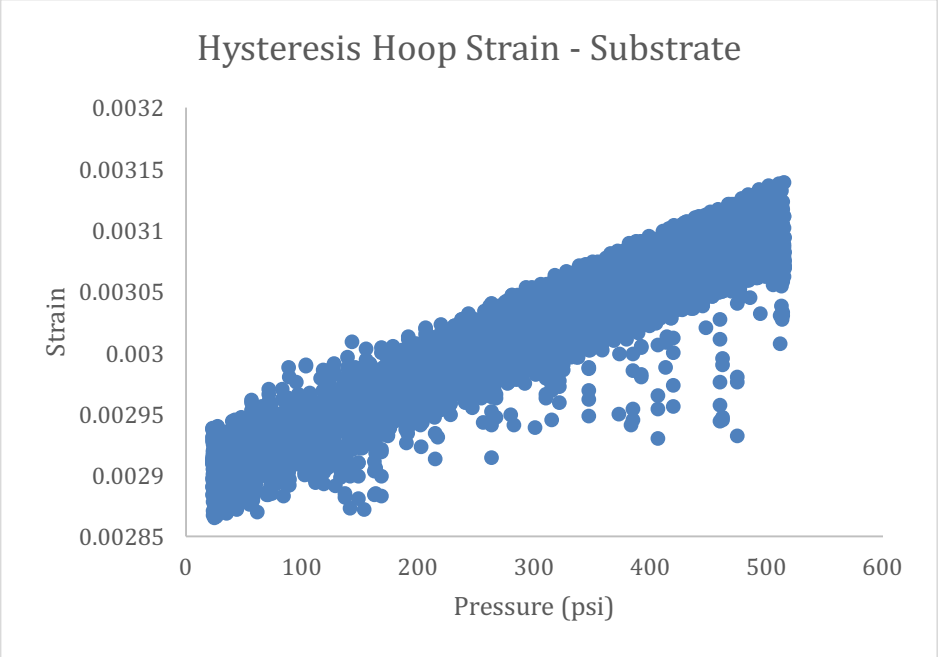

Figure 3: Strain vs. pressure for a strain gage located on the substrate n location 1.

For the strain gage in the hoop direction at location 1 in Figure 1, we see that the strain range is 0.02%, which is what we would expect from a simple thin-walled pressure vessel calculation. Representative data for the strain vs. pressure for location 1 is given in Figure 3. The noise in both Figure 2 and Figure 3, has been correlated to wire shielding issues and we have subsequently fixed this and reduced the testing noise.

Digital Image Correlation
To support the strain gage studies that we are performing during this next quarter, we are also using digital image correlation to provide full-field information about the surface strain state of the repair. These studies have just begun and we expect to present the results in the next quarterly report.

Large Scale Specimen
The large scale specimen is preparing for fabrication. We have finalized the weld drawing and expect to have the vessel completed by the end of this quarter. We will schedule installs as soon as we have completed the small-scale testing.

(c) Description of any Problems/Challenges

During this past quarter there were no significant challenges. As in last quarter, we are working to make sure that the two patch related programs are moving together and are attempting to limit any slow-downs with respect to testing conflicts for these two test programs.

(d) **Planned Activities for the Next Quarter** –
Planned activities for the next quarter include the following

1. Continue fatigue testing of small scale repairs.
2. Begin fabrication of large-scale test vessel.
3. Complete DIC study of repaired pipes.