CAAP Quarterly Report

Date of Report: June *10, 2016*

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: *May. 31, 2016*

Business and Activity Section

(a) Generated Commitments

No changes since the last report.

Supplies	Cost
Power Supply	264.00
Testing Supplies (fittings hoses etc.)	218.19
Testing Supplies (fittings hoses etc.)	459.75
Testing Supplies (fittings hoses etc.)	106.48
Testing Supplies (fittings hoses etc.)	379.09

(b) Status Update of Past Quarter Activities

During the last quarterly period we have

1. Completed all small scale tests
2. Completed strain analysis of small scale tests
3. Completed DIC analysis of small scale tests
4. Completed all installs on large scale test specimen

Small-Scale Sample Testing

All small scale tests have been completed at this point. The final results indicate that patches do perform better than full-encirclement repairs for this small scale sample. Depending on the fatigue results from the large scale specimen, we will make a proposal at an upcoming PCC-2 meeting that patches become an acceptable repair approach. We did note that the installation of strain gages underneath the repair did have a significant impact on the fatigue performance of those repairs when compared to repairs that did not have under-wrap gages. This is likely due to the use of a biaxial gage and the routing of leadwires for both gages to the same side of the repair. Future studies should be mindful of leadwire placement and routing.

DIC Study

The DIC study of all small scale specimens has been completed and we have had a chance to compare to strain data as well. One important point to note is that the location chosen for the strain gage was based on some historical decisions and is not the location of maximum strain. Figure 1 shows the DIC measured eyy strain field for one specimen. The black box in this figure is the approximate location of the on-top-of-repair biaxial strain gage. This location is not in the region of highest strain, that region is located in the area immediately above the transitions from the thin region of the wall-loss defect to the remaining undamaged pipe. This is completely expected, but there have been several historical studies run with a gage in that location. We decided to locate the gage there to help with comparisons between the current study and historical studies.

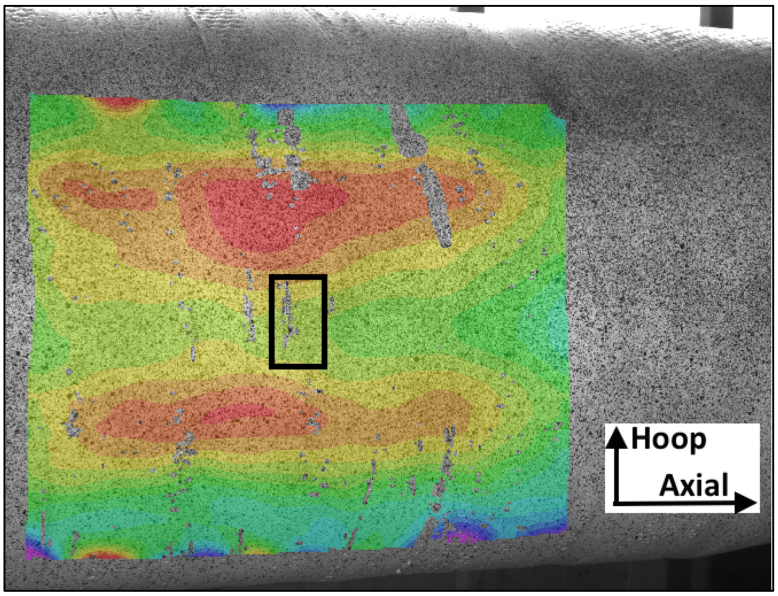

Figure 1: DIC image of eyy strain (hoop direction) from DIC analysis. Black box indicates approximate location of on-top of repair strain gage.

Table 1 shows the difference between the strains measured in the region where the strain gage was located and the maximum strains in the repair. There is a large difference between these two values. These results indicate that a full-field understanding of the repair strains is helpful to identify the areas of most concern. Under-repair analysis of failure indicated that the substrate failure initiated at the transition region, as expected. Controlling the substrate strain in this region should be a priority for repair design. This is unaddressed in the design guidance at the moment. However, the large factors of safety in the repair designs do mitigate this concern.

Table 1: Strain values gathered from DIC at gauge locations an overall maximum strain in percent strain

		Gauge Location		Overall Max Strain		Difference	
Company	**Repair**	**Hoop**	**Axial**	**Hoop**	**Axial**	**Hoop**	**Axial**
A	Patch	0.067%	0.019%	0.088%	0.069%	21%	50%
A	Full	0.121%	0.040%	0.148%	0.073%	27%	33%
B	Patch	0.188%	0.053%	0.199%	0.086%	11%	33%
B	Full	0.174%	0.043%	0.228%	0.116%	54%	73%
C	Patch	0.099%	0.047%	0.101%	0.102%	0.2%	55%
C	Full	0.061%	0.045%	0.094%	0.063%	33%	18%

Self-Sensing

We are still moving forward on the self-sensing work. At the moment, we have continued our coupon-based study using a servo hydraulic fatigue frame. We expected to begin a full-scale testing, but have had some delays due to availability of the testing system. This should be resolved this upcoming quarter and we expect to perform our initial full-scale tests. The specimen has already been fabricated and is ready as soon as a pressure fatigue system becomes available.

Large Scale Specimen

Scheduling the repairs took longer than expected, but all companies have now installed repairs on the 42 inch vessel. Testing is expected to begin this quarter and should be completed before the end of august. Repairing failed sections is the most significant challenge, but stress analysis indicates that we can weld an 8 inch flange over the defect region to serve as a repair and to allow us to continue testing. Figure 2 shows the vessel with two of the three installed patches.

Figure 2: 42 inch vessel with installed patches.

(c) Description of any Problems/Challenges

Installation of repairs on the large scale specimen took longer than expected. We now expect to finish the large scale testing by then end of the summer or early September.

(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 May 30).

1. Perform an initial on-specimen self-sensing test during the fatigue testing.
2. Begin large scale testing.