CAAP Quarterly Report

Date of Report: *April 14, 2015*

Contract Number: *DTPH56-14-H-CAP02*

Prepared for: *DOT*

Project Title: *Wall Break-through in Composite Repaired Defects*

Prepared by: *The University of Tulsa*

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For quarterly period ending: *November 30, 2014*

Business and Activity Section

(a) Generated Commitments

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

Supplies Purchased	Cost
General Lab Supplies	$13.94
FEA Tokens	$187.76
Pipe Specimens	$58.83

(b) Status Update of Past Quarter Activities

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

1. Graduate student (Omar Ramirez) was hired and has begun working on the project.
2. Completed kick-off meeting with program manager.
3. Completed initial erosion testing to determine parameters for inducing flaws.
4. Completed screening of erosion behavior of proposed composite repair system.

Initial Erosion Testing

The main goal of this research is the investigation of the influence of "realistic" flaws on the performance of repairs designed in accordance with PCC-2. A critical part of this research is the use of erosion facilities at TU to produce these realistic flaws. For the first part of this project, we are focusing on the use of simple, particle-laden gas flows to introduce erosion damage in a test specimen. We proposed to investigate elbow geometry, but as a starting point we are using straight pipe sections for some baseline testing in order to decrease the complexity of the analysis. To create flaws on a straight pipe sections, we are using an inclined flow that impinges on the side of the pipe. We are using a ground-glass particle media as this particle type is highly erosive and allows us to achieve wall break-through in schedule 40 pipe in about 1 to 3 hours, depending on the distance from the nozzle for the gas flow. Some examples of the types of flaws we are producing are shown in Figure 1. Flaw shapes and depth profiles will be investigated using a UT thickness measurement system. We are working on refining the flow geometry and parameters to produce flaws with several ranges of size and "steepness."

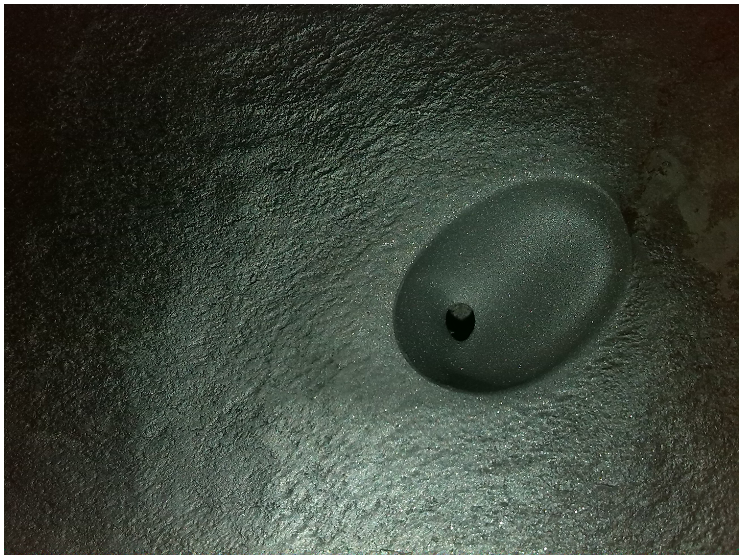

Figure 1: Image of a "realistic" flaw produced by an initial erosion test on the interior of a 6" schedule 40 pipes. The size of the hole in the damaged region is approximately 3/8 inch. This flaw took approximately 1 hour to produce.

Erosion Behavior of Composite

We are also interested in the erosion characteristics of the composite so that we can understand what happens to the composite as an internal flaw progresses to completely through-wall. To investigate this, we have conducted erosion tests on three configurations of composite material. The three configurations are shown below in Figure 2. The first two geometries are straightforward. The third geometry (C) is intended to simulate the erosion of a composite that is applied over a through wall defect. Erosive flows are directed through a hole in a steel substrate to impact a composite that is bonded to the backside of the specimen.

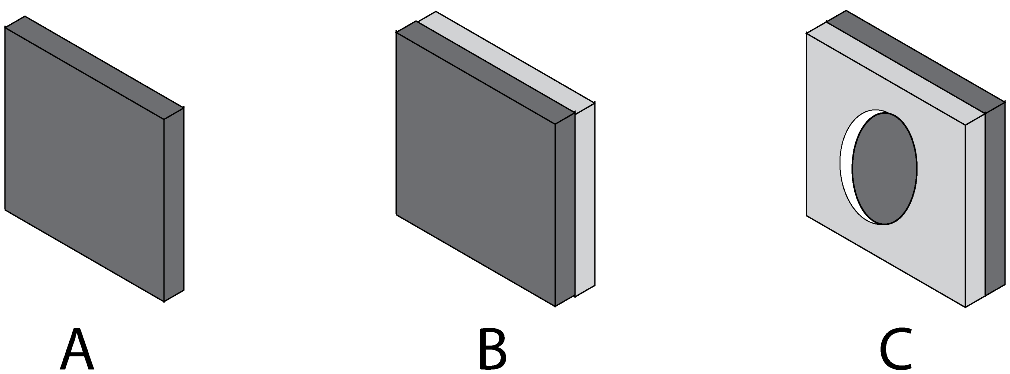

Figure 2: Schematics of the erosion samples tested for determining erosion performance of composite. Sample A is an unsupported composite material, sample B is a composite bonded to a steel substrate, and sample C is a composite bonded to the back side of a steel substrate.

The supported composite erodes at a significantly higher rate than the unsupported composite as shown in Figure 3. This is likely due to the deformation of the unsupported composite and the attendant dissipation of particle kinetic energy. We are working to make measurement on the sample geometry in Figure 2c, but the complicated structure is leading to the trapping of sand particles and subsequent mass increases.

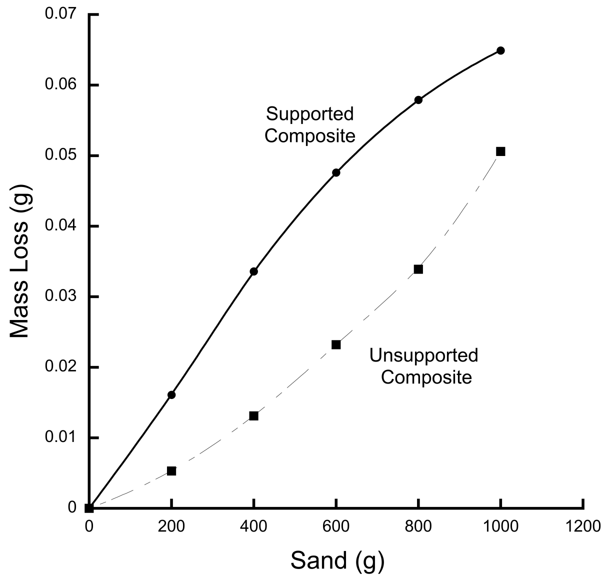

Figure 3: Mass loss of composite samples compared to mass of sand used to erode material.

(c) Description of any Problems/Challenges

No significant challenges have been encountered at this point. We are working to complete the erosion flaw characterization and should begin to start initial baseline testing of these flaws in the next quarter. We were unable to start FEA modeling of the system due to student time constraints. We plan to initiate the modeling in the next quarter.

(d) Planned Activities for the Next Quarter –

Planned activities for the next quarter include the following

1. Begin initial testing of “realistic” flaws.
2. Compare baseline results to repairs performed on drilled through-wall defects.
3. Initiate FEA modeling of the repair.