CAAP Quarterly Report

Date of Report: *December 2, 2014*

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: *November 30, 2014*

Business and Activity Section

(a) Generated Commitments

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

(b) Status Update of Past Quarter Activities

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

1. Identified graduate student for project and student was accepted by TU – Stephen Theisen
2. Contacted program manager to schedule kick-off meeting.
3. Began finite element study of repair
4. Sourced material for small and large scale specimens

During this first quarter, we have been focusing on developing finite element models of the fracture process for the proposed specimens. We expect that these models will help us understand the performance of the through-wall defects under realistic conditions. The primary goal is to allow us to understand the differences between real-world behavior and the analytical predictions in PCC-2. One of the comparisons that we are attempting to make is to compare the performance of a composite blister on a rigid substrate, as assumed in PCC-2, and a blister on a deformable substrate, as in the real repair. To accomplish this comparison, we are attempting to model a deformable flat plate with a repair. A representative simulation is shown below in Figure 1. A direct comparison between the rigid and deformed plate is somewhat complicated, but using the blister edge as a reference, we can plot the profiles of the blister as shown in Figure 2. As expected, the profile for the deformable substrate exhibits overall lower displacement levels, when compared to a rigid substrate. This is due primarily to the flattening tendency of the biaxial tensile stress state that is present in piping. The added complexity of this deformation makes the volume-change approach for calculating interfacial fracture toughness difficult to use, so we are currently implementing virtual crack closure techniques (VCCT) to help understand the crack tip stress intensity in this more realistic loading scenario.

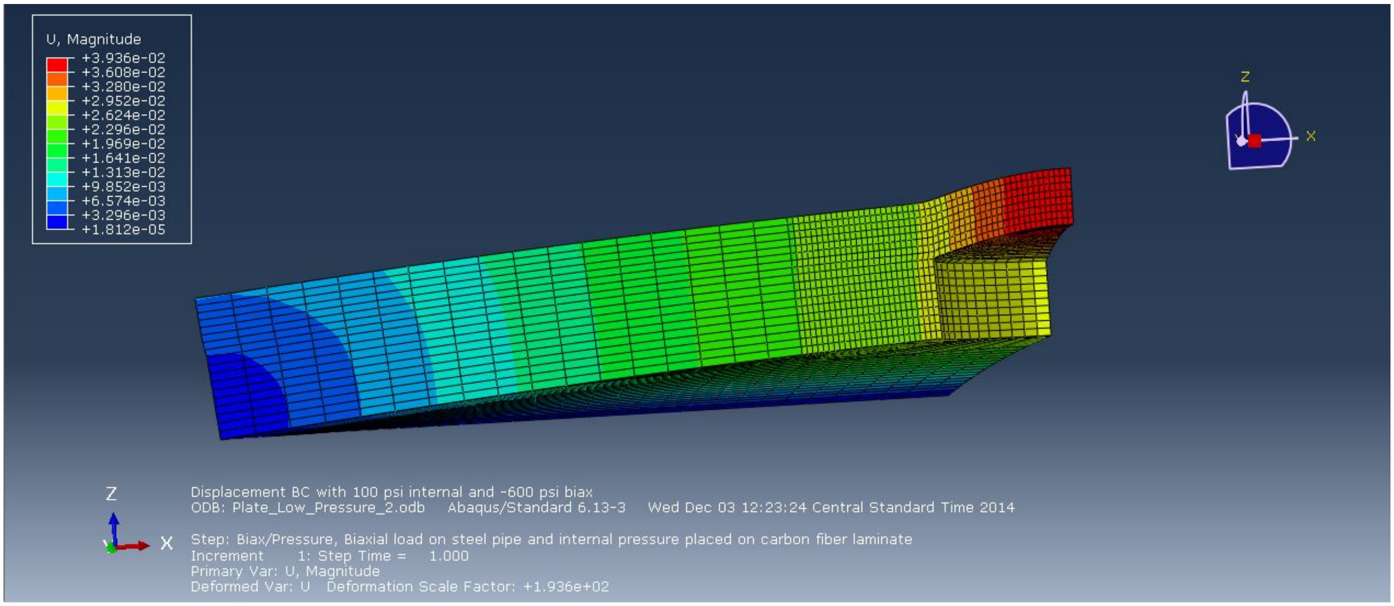

Figure 1: FEA results of a simulation of a deformable plate with applied repair. Contours represent displacement.

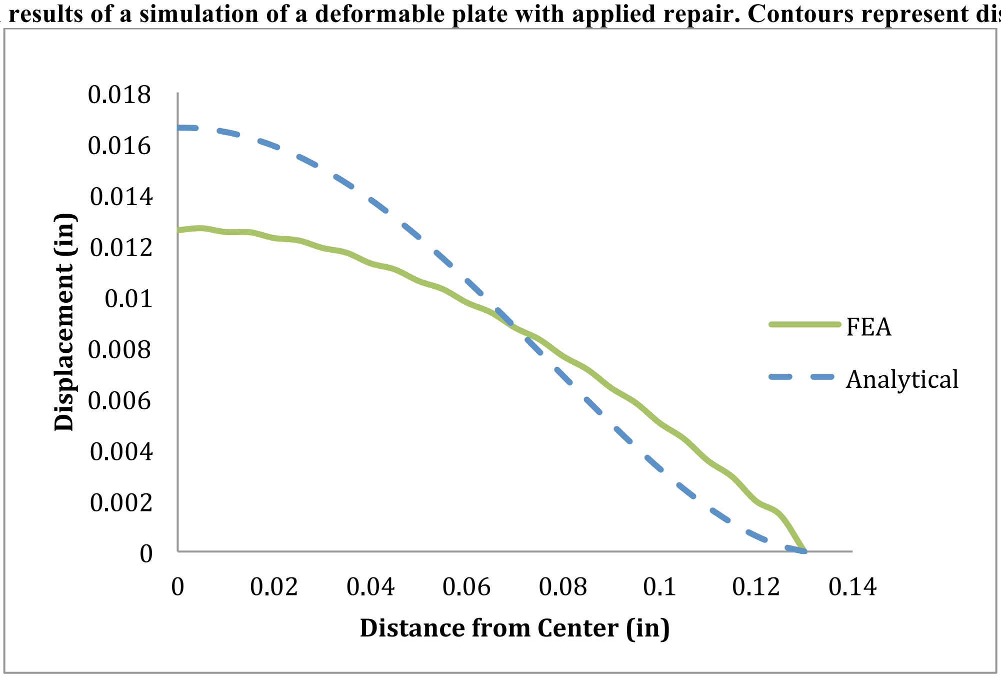

Figure 2: Comparison of a FEA-predicted blister profile and an analytical profile.

IN addition to the FEA simulations, we are preparing to order materials to fabricate the small-scale test specimens. Additionally we are working with one of the participating industrial partners to perform some initial exploratory testing so that we can refine our fatigue test protocol.

(c) Description of any Problems/Challenges

During this past quarter there were no significant challenges as we have just initiated the research project. A graduate student, Stephen Theisen, was hired at the beginning of the semester. He has begun working on the project and is coordinating with another graduate student, Chris Burnworth, to make sure that the two, patch-related projects are progressing appropriately.

(d) Planned Activities for the Next Quarter –

Planned activities for the next quarter include the following

1. Initial testing of through-hole fatigue performance.
2. Fabrication of small scale test specimens.
3. Continue FEA modeling of the repair.