CAAP Quarterly Report

Date of Report: July 1, 2019

Prepared for: *U.S. DOT Pipeline and Hazardous Materials Safety Administration*

Contract Number: 693JK31850006CAAP

Project Title: Predicting Remaining Fatigue Life of a Dent with Corrosion Using Advanced Measurements and Modeling

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For quarterly period ending: June 30, 2019

Business and Activity Section

(a) Contract Activity

Hosted Derrick Allen, James Kelly, Antoinette Penny and Joshua Arnold (via phone) from PHMSA on April 29 on Georgia Tech campus to discuss project details, student collaborations and laboratory tour.

Acquired additional legacy material from Fleet Technologies for nonlinear ultrasound (NLU) measurements in May, 2019. There were four different materials in this shipment: X-60 (US steel), x-45 (National tube), X-52 (Kaiser Steel) and X-70 (Stupp). Obtained details on previous material from Fleet in the second Quarter: API 5L Grade X-52 produced by National Tube in 1962 using a double submerged arc welding process. The microstructure should be ferrite -pearlite. Material was removed from a pipeline that was installed in 1963 and removed from service in 2017.

(b) Status Update of Past Quarter Activities (Third Quarter Activities)

The primary activities in the third quarter were on Tasks 1 and 2: Baseline nonlinear ultrasound (NLU) measurements on virgin specimens of three different pipe grades to quantify the effect of material variability on the measured NLU parameter, β, and Task 2: NLU measurements on statically loaded (or prestrained) specimens to quantify the effect of material plasticity on the measured NLU parameter, β.

Measured the NLU parameter, β in the undamaged X42 legacy material to quantify the inherent state of material nonlinearity in the undamaged material. Manufactured tensile testing specimens with this X52 material and calculated the actual stress strain curve out to an ultimate strain of approximately 0.4%. Preliminary measurements of the NLU parameter, β in the statically loaded X52 material.

(c) Cost share activity

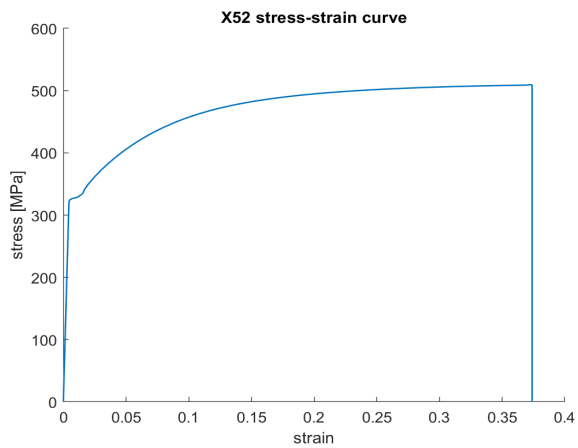
Additional legacy material provided by Fleet Technologies to the Georgia Tech team, with an approximate value of $1500. Personnel services support/expenses from Georgia Tech: support for PI

Laurence Jacobs, Dr. Jin-Yeon Kim (doctoral level Research Scientist), Denis Pfeifer (Masters student) and Mr. Gregor Wettermann (Bachelors student) with an approximate cost of 10% total.

(d) Task 1: Baseline NLU measurements on virgin specimens from three different pipe grades

Measured the NLU parameter, β in the undamaged X52 legacy material to quantify the inherent state of material nonlinearity in the undamaged material. Currently examining ways to improve the NLU measurement procedure on these curved surfaces and thus reduce the measurement error.

Task 2: NLU measurements on statically loaded (or prestrained) specimens to quantify the effect of material plasticity on the measured NLU parameter, β.



Manufactured tensile testing specimens with this X52 material and calculated the actual stress strain curve out to an ultimate strain of approximately 0.4% Preliminary measurements of the NLU parameter, β in the statically loaded X52 material. A typical stress-strain curve on the material is shown to the left.

1. Background and Objectives in the 3rd Quarter

1.1 Background

Determine the level of material nonlinearity in the X52 legacy material provided to Georgia Tech by Fleet Technologies. It is critical to understand if changes in the measured acoustic nonlinearity parameter β due to this material variability will be greater than the anticipated changes due to the accumulated fatigue and plastic damage.

1.2 Objectives in the 3nd Quarter

The measurements this quarter focused on the undamaged and statically loaded X52 legacy pipeline material where we successfully measured the acoustic nonlinearity parameter β in the undamaged material and developed a static loading procedure to prestrain the material. nonlinearity.

1. Experimental Program in the 3rd Quarter

2.1 Experimental design

Demonstrate the ability to make NLU measurements of β in the unloaded legacy X52 material.

2. Results and Discussions

The experimental results on the undamaged material showed that it is possible to obtains cumulative increase in second harmonic on actual X42 legacy material. This is a critical result for the next set of measurements in Q4. We are currently obtaining a large enough set of prestrained X52 samples to track the increase in β as a function of increasing prestrain.

3. Future work

Continue with nonlinear ultrasonic measurements in the prestrained X52 material to observe increase in β as a function of prestrain for the X52 legacy material. Currently making the β measurements on 0.2% strained specimens.