U.S. Department of Transportation

UNDERSTANDING MAGNETIC FLUX LEAKAGE (MFL) SIGNALS FROM MECHANICAL DAMAGE IN PIPELINES - DTPH56-05-T-0001

OPS ACCOMPLISHMENTS

Pipeline Safety Research and Development for Leak Detection

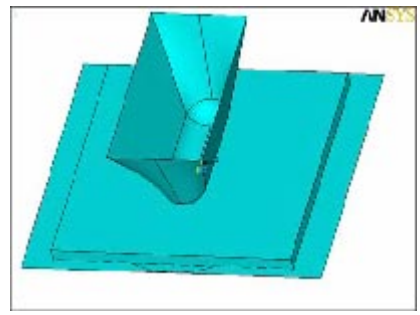
Challenge

Analyses of pipeline damage occurrences have highlighted mechanical interference as one of the most frequent sources of reported pipeline leaks and ruptures. In addition to adversely influencing the operational reliability and deliverability of pipelines, mechanical damage has been responsible for a significant proportion of the injuries and fatalities occurring within the industry. Mechanical damage (e.g., dents and gouges) produces magnetic flux leakage (MFL) signals that are unique, and are comprised of a geometry component and a characteristic component related to the residual stress present in the region of the damage. Unfortunately, at present damage-induced MFL is neither well characterized nor understood. As a result, MFL signals cannot yet be used to size and assess the severity of dents and gouges.

Technology Description

This R&D effort is to understand, identify and characterize the MFL signals arising from the geometric and residual stress components to enhance the reliability of employing MFL tools for mechanical damage detection and sizing. Specifically, MFL signal characteristics are being studied to:

1) assess the effects of dent ovality on MFL signals,
2) examine and characterize signals from dents with included corrosion, and
3) initiate study of nonsymmetrical dents in pipeline samples.



The modeled tool, die and plate used for obtaining the residual stress patterns for elongated dents.

Accomplishments

An elongated denting tool has been designed and constructed which utilizes a 50kN hydraulic press to create dents in steel plate samples. Residual stress distributions have been modelled for these dents and then used to 'assign' specific magnetic property values to particular regions within a magnetic FEA model. To date, the magnetic FEA model has been used to predict dent-geometry induced MFL signals from dents elongated in the axial direction.

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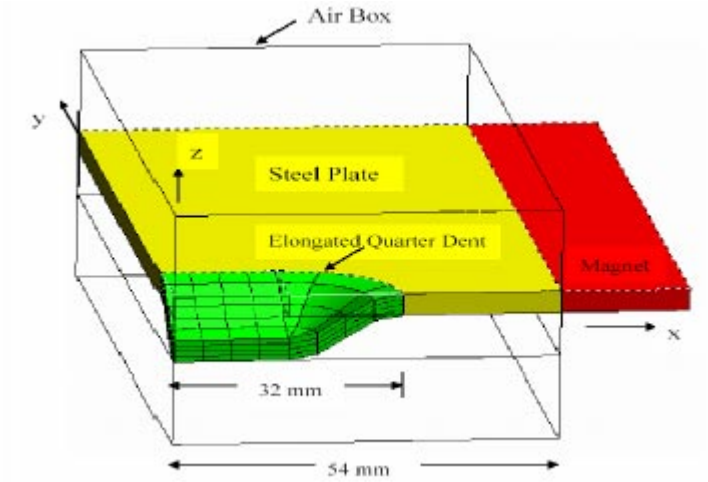

The magnetic FEA model for the axially elongated dent.

Benefits

This research will advance pipeline safety by providing detailed quantitative models for interpreting MFL signals from dents. All information will be made available to in-line inspection companies and pipeline operators to incorporate into their MFL data interpretation methods, thus improving their ability to recognize and size dents from MFL information.

Future Activities

In the remainder of this project magnetic permeability functions will be assigned to the individual segments of the magnetic FEA model. This will be done for axially- and circumferentially- oriented oval dents as well as circular dents with corrosion pits.

Partners in Success

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- **Pipeline Research Council International, Inc. (PRCI) www.prci.com**
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