ISU Efforts on Crack Versus Notch Response

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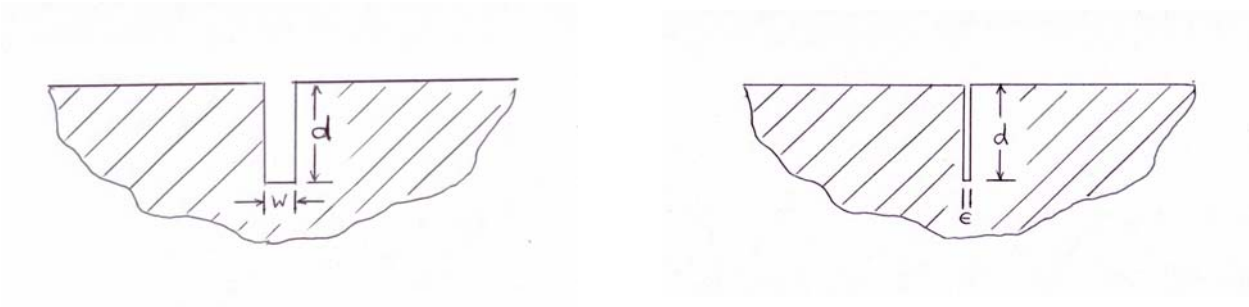
- Two Issues
  - Open notch versus closed (IDEAL) crack

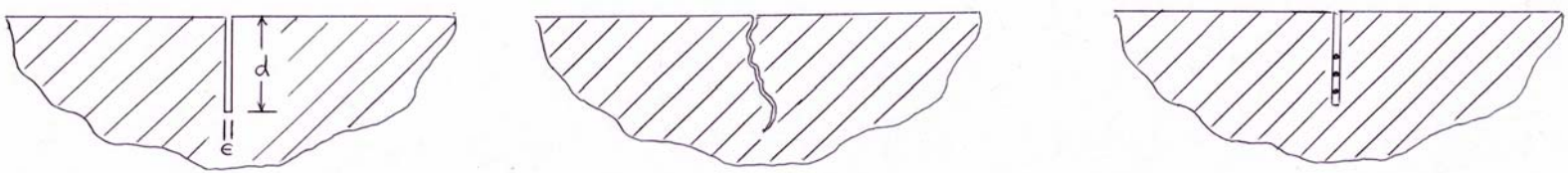


  - IDEAL closed crack versus real crack

Ideal Mathematical Crack

Morphology Effects

Electrical/Mechanical Contact Effects



Issue 1: Open Notch Response Versus Closed (IDEAL) Crack Response

- ISU working with Pratt & Whitney under Air Force contract on model validation for EDM notch response
  - Nickel-based (IN100) and titanium (Ti-6246) alloys
  - .020” x .010” x d and .030” x .015” x d
  - d=0.001”, 0.003”, 0.005”
  - samples in preparation

Issue 2: IDEAL Closed Crack Versus Real Crack Response

Quantitative Inspection Techniques for Assessing Aging Military Aircraft (AFRL)

Project 4.1 – Comparison of Defect Standards Versus Real Defects: The Effects of Defect Morphology on NDE Signals

X-Ray: J. Gray, T. Jensen, S. Wendt
EC: N. Nakagawa, C. Lo
UT: R. Roberts

Background

- Effects of defect morphology on NDE signals, as compared to standard calibration defects, is an important link to understanding NDE capability.
  - would like to determine influence of load
    - In-situ EC, UT, XR
- Complications
  - changes of coupling during loading
    - Calibration experiments
  - need to obtain independent characterization of defects
    - 3D micro CT
- A long range goal
  - make more realistic defects in a controlled fashion
    - High feature definition rapid prototyping

Objectives

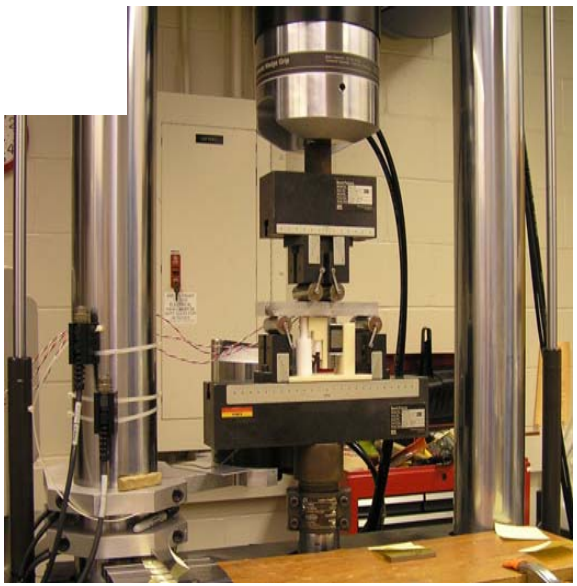
- To characterize and fabricate defects with complex geometry suitable for comparing EC and UT measurements with comparable flat bottom hole and EDM notch defects
- To Examine and demonstrate the feasibility of *in-situ* X-ray measurement under dynamic loading, so as to obtain guidelines for producing useful data for deconvolving sensor related signals from defect signals
- To examine and demonstrate the feasibility of *in-situ* EC and UT measurement under dynamical loading in an MTS machine, accompanied by strain gauge and thermocouple for compensation, so as to obtain guidelines for producing useful data for component life prediction
- To fabricate well-characterized crack morphology specimens, useful in the UT and EC measurements under dynamical loading

Milestones

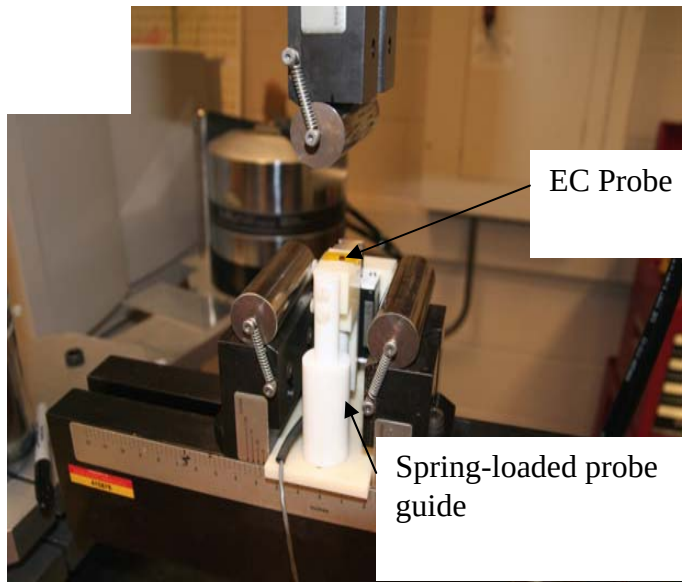
Date	Task
2 months	Selection of defect shapes and length scale for fabrication
3 months	CT scans for defect selection, fabrication of stl files for rapid prototyping
8 months	Develop 4 point loading fixture
4-15 months	Evaluation of eddy current contact issues versus flaw signals
14 months	Develop strain measurement extension to existing high energy diffraction system
18 months	Integration of CT scanning capability for defect under strain.
4-15 months	Evaluation of UT contact issues versus flaw signals
14-22 months	EC characterization of signals of complex defects.
14-22 months	UT characterization of signals of complex defects
18-24 months	In situ measurements of crack signal from UT and EC probes under dynamic load
24-26 months	Final report.

Experimental Apparatus for In-situ Tests

Four-point bend (compression)



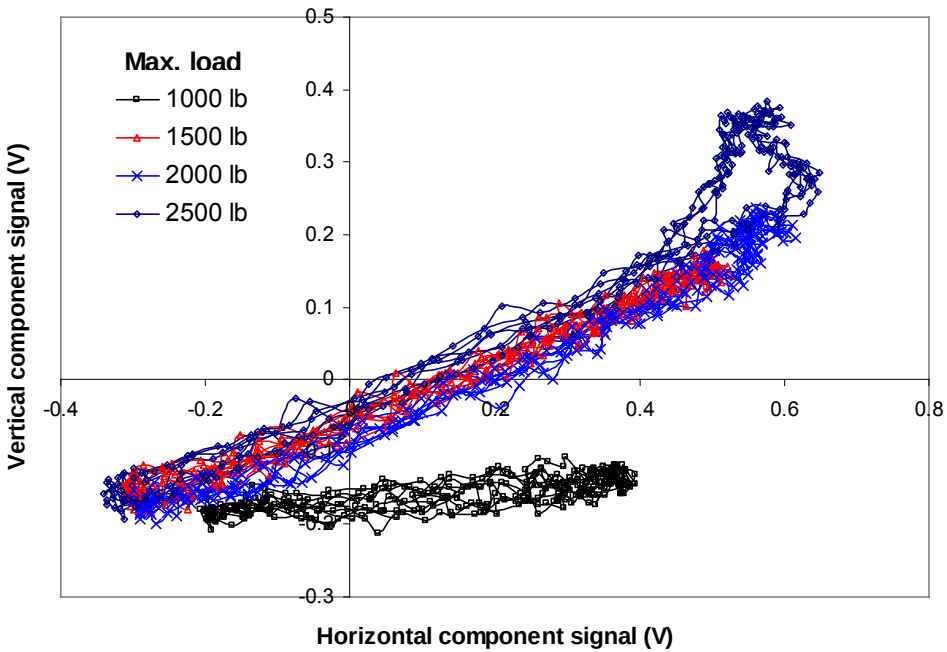
Three-point bend (tension)



An Early EC Result

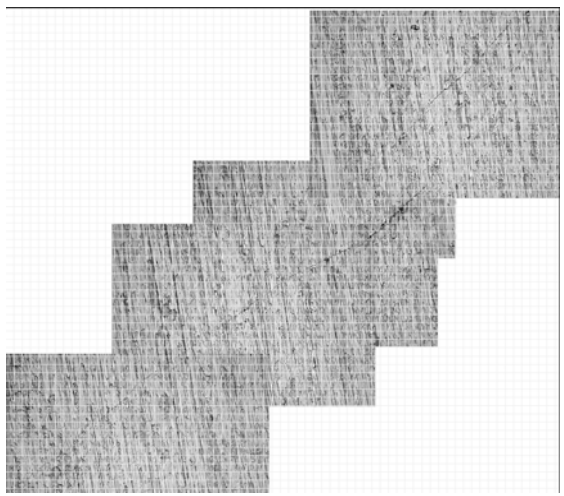
- Al 7075 bar
- NDT-19 with pencil probe
- Phase rotated such that lift-off response is horizontal
- Vertical component of signal area correcting for lift-off

  (Preliminary result intended to notionally indicate strategy; full calibration still underway)



Current EC Activity

- Fatigue crack grown in Al 6061
  - Starter notch
  - Three point bending
  - Notch removed



45° crack of overall length 0.084” (0.01”/division)

Current EC Activity

- Tensile response (three-point bending)
  - Imaginary component increases with load*
- Compressive response (four-point bending)
  - Imaginary unchanged except at highest load*
- Detailed response different than for previous crack

*significant change in real component in each case

Plans for UT Measurement Capability (Schematic)