Low Frequency Eddy Current for Sub-Surface Crack Sizing

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Outline

• Motivation
• Probe Design
• Results
• Next Steps
Why Low Frequency EC?

\[ \delta \text{(mm)} = 50.3 \sqrt[4]{\frac{\rho}{\mu_0 f}} \]

<table>
<thead>
<tr>
<th>Aluminum</th>
<th>Resistivity ((\mu\Omega \cdot \text{cm}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>7050-T76</td>
<td>4.36</td>
</tr>
<tr>
<td>6061-T4</td>
<td>4.30</td>
</tr>
<tr>
<td>7075-T6</td>
<td>5.39</td>
</tr>
<tr>
<td>2024-T3</td>
<td>5.33</td>
</tr>
</tbody>
</table>
Problem
Problem

Inspection Surface

Fretting Crack

IB  FWD
QETE Standard

QETE Project A014812, F188 Stub Flange LFEC Calibration Block
Material = Aluminum 40% IACS, +/- 2%
Surface Finish =
Block Tolerance = +/- .005"
Hole Tolerance = +.000 / -.002
Notch Width = .005" +/- .002", Length to Depth Ratio = 2/1
Die-Sink Electrode Angle = 26.6 deg
31 July 2014
Probe Configurations

Concentric

Beside
Modelling (Comsol)
Concentric Probe
Beside Configuration
Concentric Configuration
Testing

Bolt

20°

Sample Edge
Results (Concentric)

200 Hz

Depth from Scanning surface

No Notch
0.01”
0.03”
0.05”
0.07”
0.09”
0.11”
0.12”
Results (Concentric)
Results (Beside)

500 Hz

Depth from Scanning surface

<table>
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<tr>
<td>0.01”</td>
</tr>
<tr>
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</tr>
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</tr>
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<td>0.12”</td>
</tr>
</tbody>
</table>
Results (Beside)

560 Hz and 5 kHZ

- No Notch
  - 0.01"
  - 0.03"
  - 0.05"
  - 0.07"
  - 0.09"
  - 0.11"
  - 0.12"

Depth from Scanning surface
Next Steps

• “Real” piece
  • Changing edge distance
  • Bolt not perpendicular to scanning surface
  • Inspection surface not parallel to scanning surface

Section B-B
Questions
Next Steps

• Issues with uneven scanning surface
• Do we really need a different probe for each bolt size?