The Efficacy of Friction Stir Welding in High Strength Steel Production
Timothy Fountain
(South Dakota School of Mines & Technology)
Faculty Advisors: Dr. Bharat Jasthi, Dr. Michael West

Introduction
- Friction stir welding (FSW) is a solid state welding process in which a rotating bit generates heat and stirs material together
- Offers significantly better mechanical properties than traditional fusion methods
- Very beneficial in high strength applications where welded material must maintain pre-weld properties
- Concerns about slow travel speed and excessive tool wear exist

Project Goals
- Maximize weld parameter efficiency while maintaining mechanical properties of parent material
- Explore tools that are both able to withstand rigors of production and are cost effective
- Compare results with fusion welding methods

Procedure
- Tools chosen
- Weld parameters developed
- Microstructural characterization
- Mechanical property evaluation

Parameter Development & Microstructural Characterization

Discussion
- Higher heat input creates a larger HAZ region
- Martensitic transformation leads to increased hardness and decreased ductility in weld nugget
- Post weld heat treatment returns hardness and ductility to acceptable levels
- Tensile properties are superior to fusion welding processes

Conclusions
- Mechanical properties obtained from FSW material is superior to fusion welding methods
- Efficiency in a steel production setting still questionable
- Tool wear so far a non issue, but more data is needed to determine production feasibility

Future Work
- Sub critical welding
- Fatigue testing
- Quantitative tool wear studies

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Table 1: Results of tensile testing of parent material and FSW material.

<table>
<thead>
<tr>
<th>Material Condition</th>
<th>YS (ksi)</th>
<th>UTS (ksi)</th>
<th>Elongation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent Material (as rolled)</td>
<td>108 ± 0.2</td>
<td>148 ± 1.4</td>
<td>6.5 ± 0.7</td>
</tr>
<tr>
<td>Parent Material (thick, heat treated)</td>
<td>121 ± 0.4</td>
<td>148 ± 0.8</td>
<td>11.7 ± 0.8</td>
</tr>
<tr>
<td>Parent Material (thin, heat treated)</td>
<td>123 ± 0.4</td>
<td>143 ± 1</td>
<td>12.2 ± 1</td>
</tr>
<tr>
<td>Transverse Weld (as welded)</td>
<td>123 ± 1.6</td>
<td>152 ± 10.5</td>
<td>3.2 ± 0</td>
</tr>
<tr>
<td>Transverse Weld (heat treated)</td>
<td>121 ± 1.4</td>
<td>147 ± 1.8</td>
<td>10.6 ± 1.4</td>
</tr>
<tr>
<td>Longitudinal Weld (as welded)</td>
<td>128 ± 0.8</td>
<td>216 ± 10.7</td>
<td>N/A</td>
</tr>
<tr>
<td>Longitudinal Weld (heat treated)</td>
<td>145 ± 7.9</td>
<td>155 ± 4.4</td>
<td>10.4 ± 1.2</td>
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