ABSTRACT:

Friction-stir welding (FSW) is a solid-state joining process (the metal is not melted) and is used when the original metal characteristics must remain unchanged as much as possible. It mechanically intermixes the two pieces of metal at the place of the join, then softens them so the metal can be fused using mechanical pressure, much like joining clay, dough, or plasticine. It is primarily used on aluminum, and most often on large pieces that cannot be easily heat-treated after welding to recover temper characteristics. In this project, FEA analysis is performed for friction stir welding of aluminum and copper. The welds are produced by varying the process parameters; the rotational speed at 900 rpm and the welding speed varied between 60 and 80 mm/min. Thermal analysis are done. A parametric model with the weld plates and cutting tool is done in Creo-2. The effects of different tool pin profiles on the friction stir welding are also considered for analysis. Different tool pin profiles are square and circular. So in this project we want to create simple model of FSW tool and two work pieces to be joined by butt by using Creo software and also analysis the working pieces that is effected by the thermal stress that are applied on it.

INTRODUCTION TO FRICTION STIR WELDING:

Friction-stir welding (FSW) is a solid-state joining process (meaning the metal is not melted during the process) and is used for applications where the original metal characteristics must remain unchanged as far as possible. This process is primarily used on aluminum, and most often on large pieces which cannot be easily heat treated post weld to recover temper characteristics.
The welding of the material is facilitated by severe plastic deformation in the solid state, involving dynamic recrystallization of the base material.

**FIG: 3-D MODEL OF FRICTION SURFACING**

**MODELS OF CUTTING TOOLS**

**ROUND TOOL**

**PLATE1**

The above figure shows the 3-d modeling of plate1.

**PLATE2**

The above shows the 3-d modeling of plate2.

**ROUND TOOL**

The above figure shows the 3-d modeling of round tool.

**ROUND TOOL ASSM**

The above figure shows the assembly of round tool.

**SQUARE TOOL**

The above figure shows the 3-d modeling of square tool.

**SQUARE TOOL ASSMENMBLY**

**FIGURE 17. Model (C4, D4) > Static Structural (D5) > Solution (D6) > Shear Stress > Figure**

**FIGURE 12. Model (E4, F4) > Static Structural (F5) > Imported Load (E6) > Imported Body Temperature > Figure**

**FIGURE 15. Model (E4, F4) > Static Structural (F5) > Solution (F6) > Equivalent Elastic Strain > Figure**

**FIGURE 18. Model (E4, F4) > Static Structural (F5) > Solution (F6) > Shear Stress > Figure**

**TABLE 2**

Copper Alloy > Constants

**TABLE 15**

H13 Steel > Constants
The welding of the material is facilitated by severe plastic deformation in the solid state, involving dynamic recrystallization of the base material.

**FIG: 3-D MODEL OF FRICTION SURFACING**

Models of Cutting Tools
- Round Tool
- Plate1
- Plate2
- Round Tool Assembly
- Square Tool
- Square Tool Assembly

**TABLE 2:** Copper Alloy > Constants

<table>
<thead>
<tr>
<th>Thermal Conductivity</th>
<th>2.43e-002 W mm⁻¹ C⁻¹</th>
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<tbody>
<tr>
<td>Density</td>
<td>7.8e-006 kg mm⁻³</td>
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</table>

**TABLE 15:** H13 Steel > Constants
TABLE 16: H13 Steel > Isotropic Elasticity

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Young’s Modulus (MPa)</th>
<th>Poisson’s Ratio</th>
<th>Bulk Modulus (MPa)</th>
<th>Shear Modulus (MPa)</th>
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</thead>
<tbody>
<tr>
<td>2.1e+005</td>
<td>0.3</td>
<td>1.75e+005</td>
<td>80769</td>
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ANALYSIS RESULTS SUMMERY

<table>
<thead>
<tr>
<th>Round probe with 900 rpm at transverse speed of 80 mm/sec</th>
<th>Round probe with 900 rpm at transverse speed of 60 mm/sec</th>
<th>Square probe with 900 rpm at transverse speed of 80 mm/sec</th>
<th>Square probe with 900 rpm at transverse speed of 60 mm/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>Total Heat Flux (w/mm²)</td>
<td>Total Deformation (mm)</td>
<td>Equivalent Stress (MPa)</td>
</tr>
<tr>
<td>460</td>
<td>3.13</td>
<td>1.49</td>
<td>50600</td>
</tr>
<tr>
<td>460</td>
<td>3.13</td>
<td>1.12</td>
<td>37941</td>
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<tr>
<td>460</td>
<td>2.45</td>
<td>1.40</td>
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<tr>
<td>460</td>
<td>2.45</td>
<td>1.05</td>
<td>27773</td>
</tr>
</tbody>
</table>

CONCLUSION:

In our project we have designed 2 types of cutting tools Round and Square for doing Friction Stir Welding of two dissimilar materials Aluminum alloy 6061 and Copper running at speed of 900 rpm. We have conducted FEA process thermal analysis on tools Round and square tool to verify the temperature distribution, thermal flux, and stresses at different transverse speed. By observing the results, thermal flux and thermal gradient are more for square tool and the stresses produced are more than round tool. Temperature is also produced for required melting point of plates. So for using Friction Stir Welding, round cutting tool is more effective than square tool from FEA results.

References: