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Investigation of Thermal Field in Friction Surfacing

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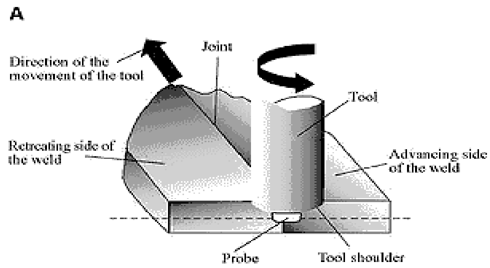
ABSTRACT:

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 aluminium 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-2The 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.

PRINCIPLE OF OPERATION:



Schematic diagram of the FSW process: (A) Two discrete metal work pieces butted together, along with the tool (with a probe). The progress of the tool through the joint, also showing the weld zone and the region affected by the tool shoulder.In FSW, a cylindrical-shouldered tool, with a profiled threaded/unthreaded probe (nib or pin) is rotated at a constant speed and fed at a constant traverse rate into the joint line between two pieces of sheet or plate material, which are butted together. The parts have to be clamped rigidly onto a backing bar in a manner that prevents the abutting joint faces from being forced apart. The length of the nib is slightly less than the weld depth required and the tool shoulder should be in intimate contact with the work surface. The nib is then moved against the work, or vice versa. Frictional heat is generated between the wear-resistant welding tool shoulder and nib, and the material of the work pieces. This heat, along with the heat generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without reaching the melting point (hence cited a solid-state process), allowing the traversing of the tool along the weld line in a plasticized tubular shaft of metal. As the pin is moved in the direction of welding, the leading face of the pin, assisted by a special pin profile, forces plasticized material to the back of the pin while applying a substantial forging force to consolidate the weld metal.

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

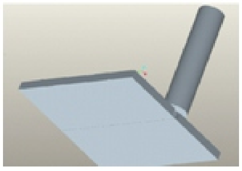
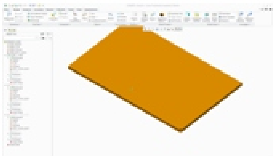


FIG: 3-D MODEL OF FRICTION SURFACING

MODELS OF CUTTING TOOLS

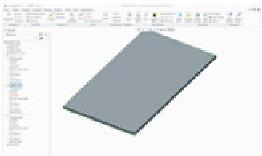
ROUND TOOL

PLATE1



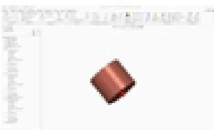
The above figure shows the 3-d modeling of plate1.

PLATE2



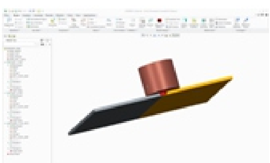
The above shows the 3-d modeling of plate2.

ROUND TOOL



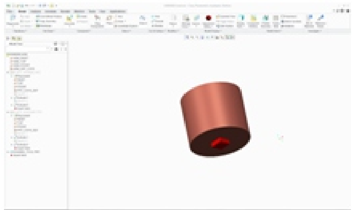
The above figure shows the 3-d modeling of round tool.

ROUND TOOL ASSM



The above figure shows the assembly of round too

SQUARE TOOL



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

SQUARE TOOL ASSMEMBLY

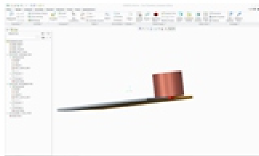


FIGURE 17. Model (C4, D4) > Static Structural (D5) > Solution (D6) > Shear Stress > Figure

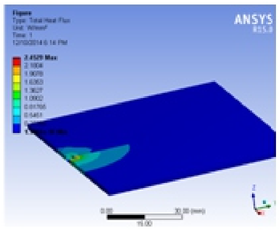


Figure: Total heat flux on welding plates

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

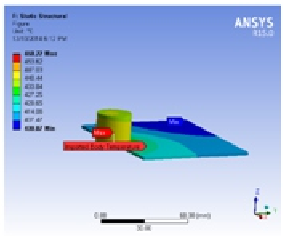


Figure: Imported body temperature on welding plates

FIGURE 15.Model (E4, F4) > Static Structural (F5) > Figure

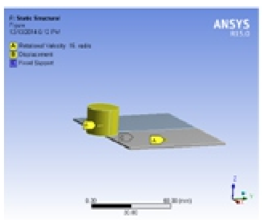


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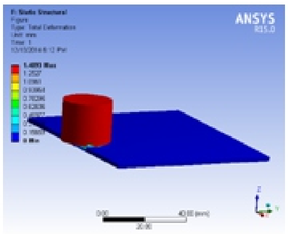
FIGURE 16
Model (E4, F4) > Static Structural (F5) > Solution (F6) > Total Deformation > Figure



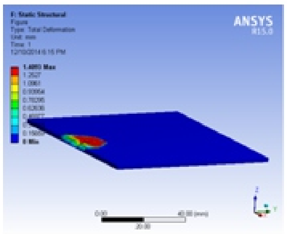
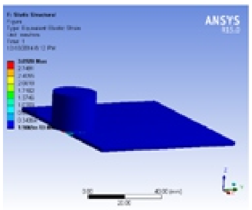


Figure: Total deformation on welding plates

FIGURE 18.Model (E4, F4) > Static Structural (F5) > Solution (F6) > Equivalent Elastic Strain > Figure



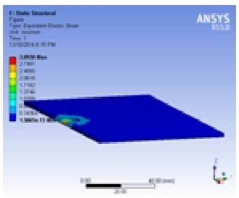
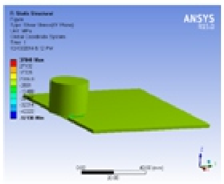


Figure: Equivalent Elastic Strain on welding plates

FIGURE 19.Model (E4, F4) > Static Structural (F5) > Solution (F6) > Shear Stress > Figure



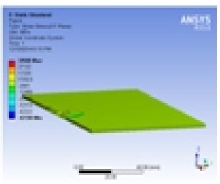


Figure: Shear stress on welding plates

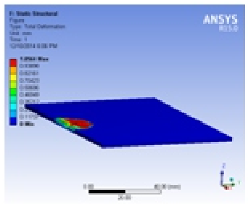
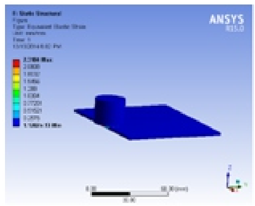


Figure: Total deformation on welding plates

FIGURE 9.Model (E4, F4) > Static Structural (F5) > Solution (F6) > Equivalent Elastic Strain > Figure



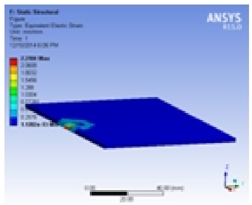
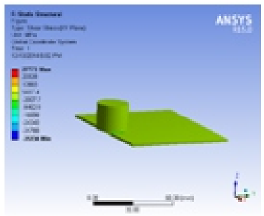


Figure: Equivalent elastic strain on welding plates

FIGURE 10.Model (E4, F4) > Static Structural (F5) > Solution (F6) > Shear Stress > Figure



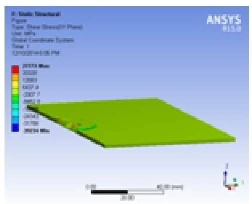


Figure: shear stress on welding plates

TABLE 2:Copper Alloy > Constants

TABLE 15:H13 Steel > Constants

Thermal Conductivity	2.43e-002 W mm^-1 C^-1
Density	7.8e-006 kg mm^-3

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TABLE 16: H13 Steel > Isotropic Elasticity

Temperature C	Young's Modulus MPa	Poisson's Ratio	Bulk Modulus MPa	Shear Modulus MPa
	2.1e+005	0.3	1.75e+005	80769

ANALYSIS RESULTS SUMMERY

Round probe with 900 rpm at transverse speed of 80 mm/sec				
Temperature (°C)	Total Heat Flux(w/mm^2)	Total Deformation (mm)	Equivalent Stress (Mpa)	Equivalent Elastic Strain
460	3.13	1.49	50600	3.79
Round probe with 900 rpm at transverse speed of 60 mm/sec				
460	3.13	1.12	37941	2.84
Square probe with 900 rpm at transverse speed of 80 mm/sec				
460	2.45	1.40	37040	3.09
Square probe with 900 rpm at transverse speed of 60 mm/sec				
460	2.45	1.05	27773	2.31

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.

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