Analysis of Friction Stir Welded of Dissimilar Metals by using Ansys

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Abstract— Friction Stir Welding (FSW) is a solid state welding process in which the heat for welding is produced by the relative motion between the tool and the two interfaces being joined. This method relies on the direct conversion of mechanical energy into thermal energy to form the weld without the application of heat energy from any other source. The rotational speed of the tool, the axial pressure of the tool and the welding time are the principle variables that are controlled in order to provide the necessary combination of heat and pressure to form the weld. In this project, FEA analysis is performed for friction stir welding of dissimilar metals. The welds are produced by varying the process parameters; the rotational speed and welding speed mm/min. Structural and thermal analysis are done. A parametric model with the weld plates and round cutting tool is done in Pro/Engineer.

Key words: FEA, FSW and Ansys

I. INTRODUCTION

In traditional or fusion welding the material must be melting and re solidified, but in case of FSW, the joint is in solid state it never melts. Instead, the joint is created under conditions of severe plastic deformation [1]. The big difference between FSW and fusion welding (other than the lack of melting) is the ability to manipulate peak temperatures by choice of different welding parameters. This can be achieved accurately. This will reduce the time for simulation. FSW provides the ability to manipulate the properties of the metal and tailor them for different applications, and possible to optimize tensile strength, fracture toughness, or fatigue resistance based on the particular application [2]. Improvements in tool design have been shown to cause substantial improvements in productivity and quality. TWI has developed tools specifically designed to increase the depth of penetration and so increase the plate thickness that can be successfully welded. In this project, analysis of FSW on dissimilar metals with ansys software. Initial the design made in pro-E with standard dimensions of the specimens and meshed it with help of the software. Tool profile is designed with different shapes like circular and square. During welding process, stresses developed for different tool profiles will be different and thermal gradient and flux of plates will be identified by the process [3].

II. EXPERIMENTAL DETAILS

A. *Design of Plate and Profile Tools in Pro-E*

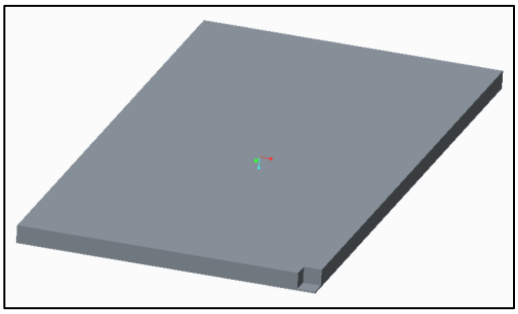

Fig. 1: designing of plate in pro-E

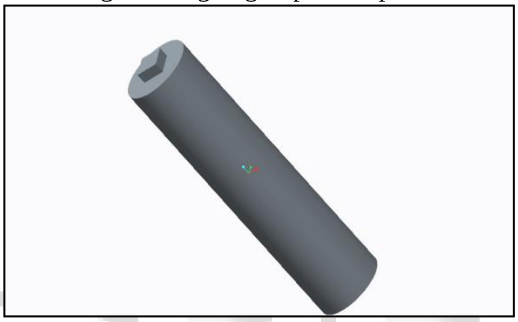

Fig. 2: square profile tool

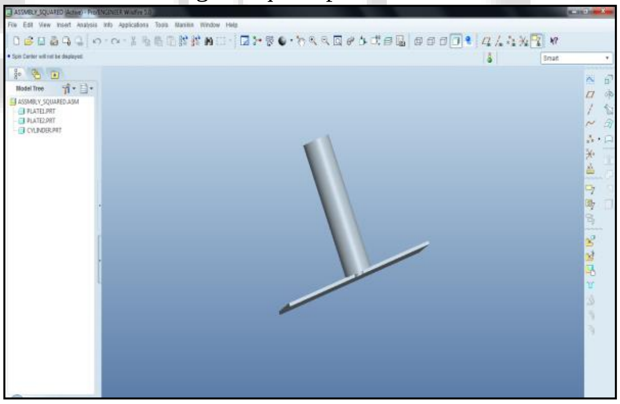

Fig. 3: Assembled for FSW process

B. *Coupled Field Analysis of Aluminum Alloy and Copper for Round Tool At 1000 Rpm*

- Software used is ANSYS10
- Type of analysis done- Couple field analysis
- Enter units-/units, mm, kg, sec, k
- Set working directory
- Change job name
- Select Preference select thermal
- Select element type as a solid brick 20 node 90
- Enter material properties as a thermal conductivity 0.18 W/mm. K
- Enter material properties as a specific heat 896 J/Kg-^{0}K.

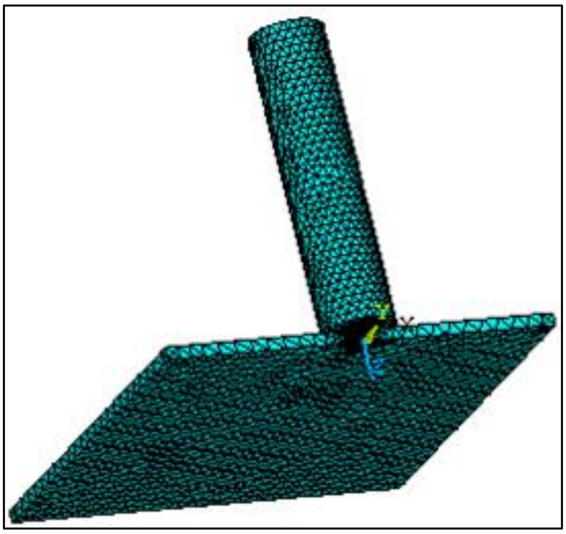

Fig. 4: Meshing the sample

- Film Coefficient – 0.02 W/mm K
- Bulk Temperature – 308K
- Select solution-solve- current LS
- Select finish option
- Select preprocessor-physics-read-structural
- Loads-Define, loads-Apply-structural- Displacement-select top area of the cutting tool.
- Pressure- on areas- enter 19.68MPa
- Inertia- angular velocity: 104.719 rad/sec.

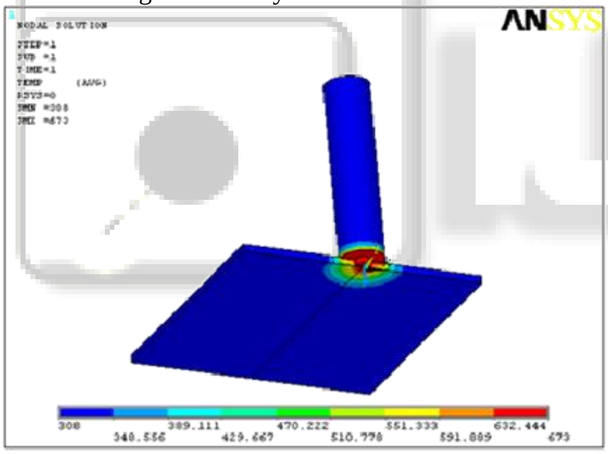

Fig. 5: Temperature distribution

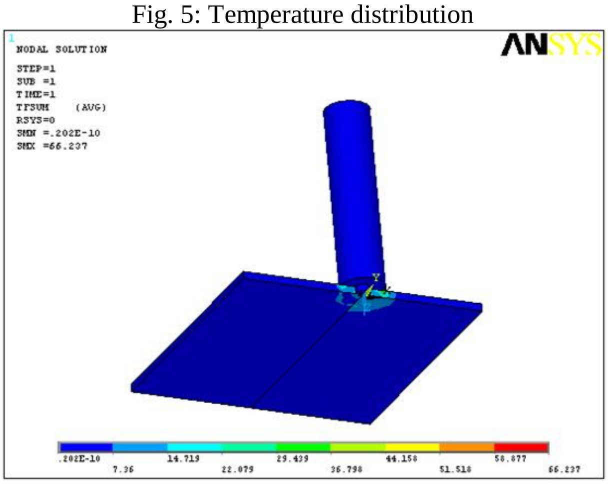

Fig. 6: Nodal solution of thermal flux

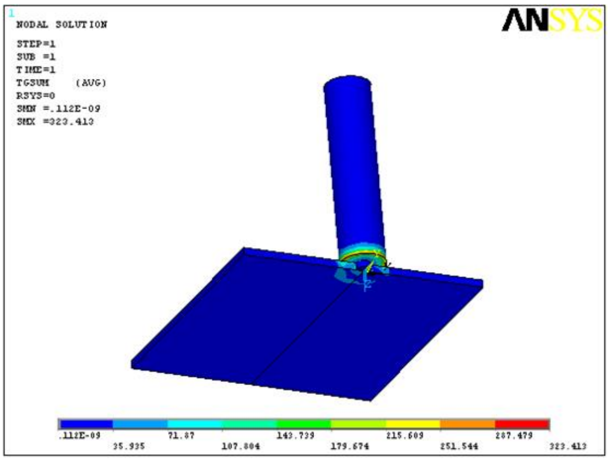

Fig. 7: Nodal solution of Thermal Gradient

C. Structural Analysis of Aluminum Alloy and Copper for Round Tool At 1000 Rpm

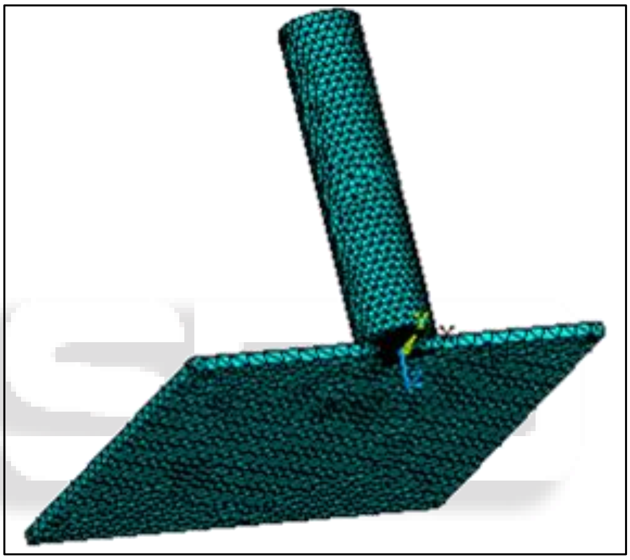

Fig. 8: Meshing the sample

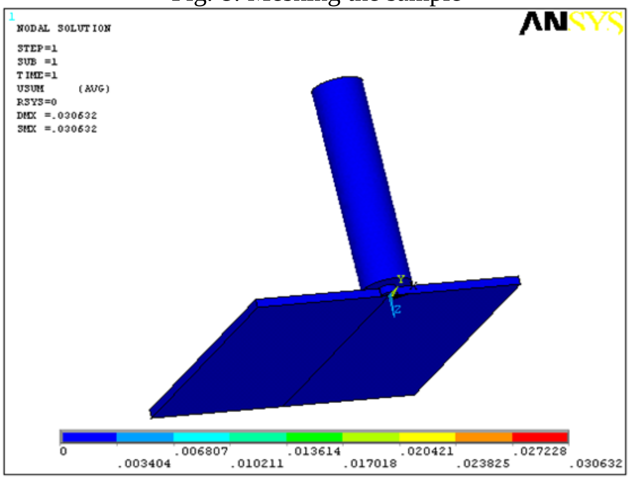

Fig. 9: Nodal solution of displacement

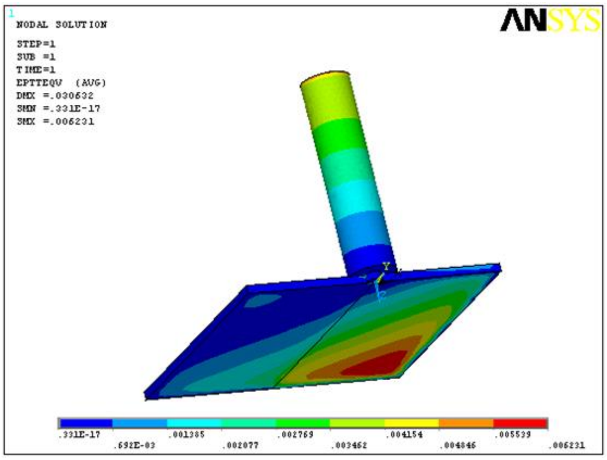

Fig. 10: Nodal solution of stress

S.NO	Thermal Flux (W/mm^2)	Thermal Gradient (K/mm)
Round tool	66.237	323.413

Table 1: Thermal analysis of round tool at 1000rpm

S.NO	Stress (N/mm^2)	Displacement (mm)
Round tool	1191	0.030632

Table 2: Structural analysis of round tool at 1000 rpm

III. CONCLUSIONS

- Thermal Flux was found to be 66.237 W/mm^2 for round tool profile at 1000 rpm.
- Thermal Gradient was found to be 323.413 K/mm for round tool profile at 1000 rpm.
- During structural analysis stress found to be 1191N/mm^2 and displacement was 0.030632 mm for round tool profile at 1000 rpm.
- By varying the profile of the tool, it shows different thermal and structural results.

REFERENCES

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