

A CASE STUDY ON WELDABILITY OF ALUMINUM ALLOY (AA 6082-T651) WITH RESISTANCE SPOT WELDING PROCESS WITH FEA AND ANSYS ANALYSIS

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ABSTRACT

The continuous trend of automotive weight reduction have increased focus of attention of many researchers on weldability of Aluminum alloys with Resistance Spot Welding process for the manufacturing. Due to inferior weld ability of Aluminum alloys for RSW, it faces a major problem of determining the optimum parameter and it is very difficult to evaluate the welding procedure quantitatively. The aim of this study is focused on investigation of the process parametes for RSW of aluminum alloys (AA 6082-T651) with help of ANSYS workbench 15.0.0 software. The general resistance profile is determined by the total welding heat input. However, the resistance is also affected by the dynamics of applied electric current, and resistance of the base metal changes proportionally to the welding current for a very short period of time (i.e., milliseconds), this short acting time is known as transient effect. Welding physics says that the electrical current changes faster than the dynamic resistance of the work piece, which is the indication of accumulated heat input. This paper presents a basic investigations with ANSYS workbench 15.0 for effect of operating parameters like electrode force, current and cycle time 1s for a resistance spot welding process of aluminium alloy 6082-T651for the plate thickness 1.0 mm. The RSW of aluminium alloy will ask for proper process parameters to increase its weld quality. Aluminium alloy 6082 T651 can be a suitable replacement of AA5754 for different application with good economy and strength. Thermal analysis shows that aluminium alloy 6082-T651 can be used for substitute of AA5754 aluminium alloy for reduction of cost of materials in automobile industry with the application of resistance spot welding process .

Keywords: Resistance spot welding, aluminum alloys, 6082-T651.

Introduction

Resistance spot welding is widely used in industry especially in vehicle manufacturing field and the electronic instruments due to having good rate of welding process, good quality of joints and low cost. Nowadays, the use of aluminum alloys in automotive industry is very common and is used instead of steel alloys because of their advantages like low weight. Aluminum alloys are usually more difficult to weld. This is because of their narrow plastic range, low bulk resistance and greater thermal conductivity.[1]

Consumption of fuel in automobile should be optimum is the highest priority now days For which light metal should be used giving higher load baring capacity and tensile strength for this purpose resistance spot welding (RSW) of aluminum alloys was studied in which higher tensile strength, penetration etc. is the motive of study by varying different process parameter such as welding force, welding current, welding time for different arrangement sheet

Software process

The selected material in this investigation is 1mm thick 6082-T651 aluminum alloy sheets whose chemical composition and mechanical properties have been presented in Tables 1 and 2, respectively.

Table 1. Chemical composition of the 5083-O

Aluminum alloy							
Cu	Si	Fe	Mn	Mg	Zn	Ti	Al
0.0	0.9	0.1	0.6	0.8	0.0	0.0	B
30	30	50	60	00	50	40	al

Values are given in percentages

Table 2. Mechanical properties of the 6082-T651

Aluminum alloy				
Young' s modulus (GPa)	Yield stress (MPa)	Tensile strengt h (MPa)	Elongatio n (%)	Poisson' s ratio
70	300	250	9	0.33

Step-I Modelling:

Geometry was made by stress and strain analysis with the help of ANSYS 15.0.0 software. It has completed by electrode and plate.

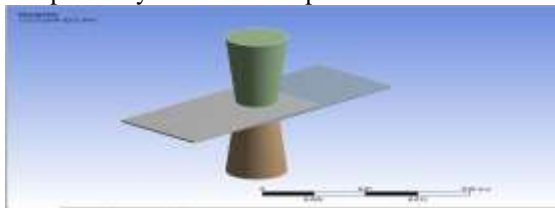


Figure:1 Simple geometry for software analysis Boundary conditions are defined as bottom electrode and both the plates are fixed at thickness side. Meshing process was carried out with hex meshing on plate surface and fine meshing was applied on nugget area. Fin meshing was used gets for more accurate results. Figure 2 shows the meshed geometry of 1 mm plate.

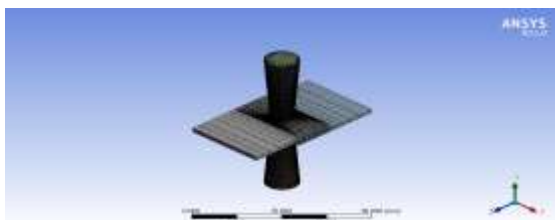


Figure: 2 Meshing in 1mm plate

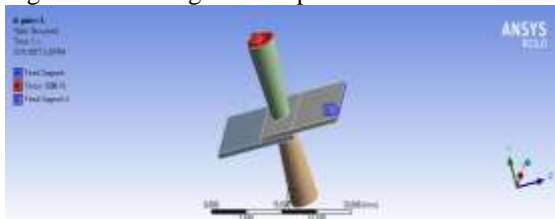


Figure:3 Boundary condition

Figure: 3 shows the applied boundary conditions to plate side and bottom electrode as fixed and applied 1000 N force on upper electrode.

Step II Thermal Analysis

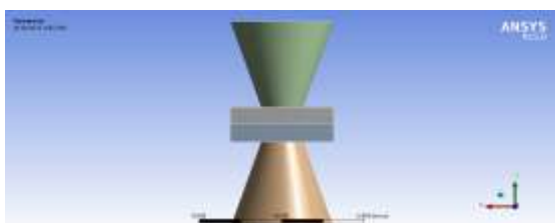


Figure: 4 Simple Geometry for thermal analysis

This geometry made for thermal analysis with suitable boundary condition as bottom electrode is fixed with respect to z and x directions as shown in Figure 5. with applied force of 3000 N on upper electrode.

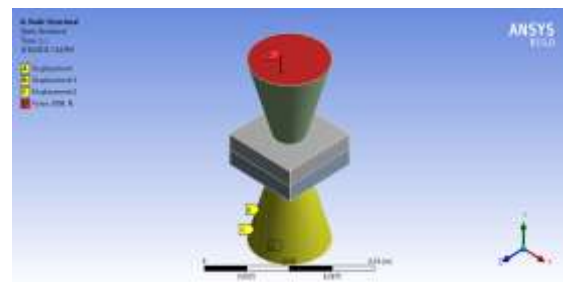


Figure: 5 Boundary Condition for static structural

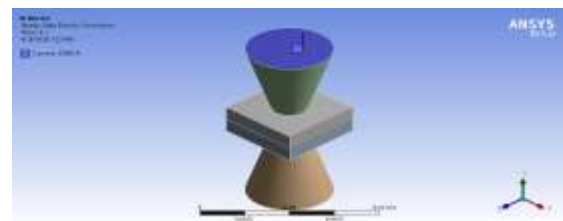


Figure: 6 Boundary condition for Electrical

Figure :6 shows electrical boundary condition applied for thermal analysis with 15000 A applied on upper electrode. Figure : 7 represents applied transient transient boundary conditions for convective heat transfer coefficient taken as 5 W/m²C at temp. of 22⁰ C.

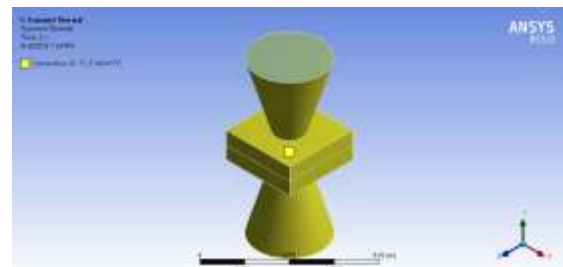


Figure:7 boundary condition for Transient Thermal



Figure:8 Meshing

Figure : 8 shows applied hex meshing on plate surface and especially fine meshing applied on nugget area to get more accurate results.

Step III Analysis

Figure: 9 shows the stress induced in the plates due to electrode force application of electrode force 1000 N.

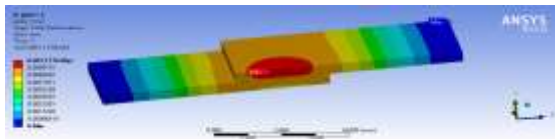


Figure:9 maximum deformation in 1mm plate thickness

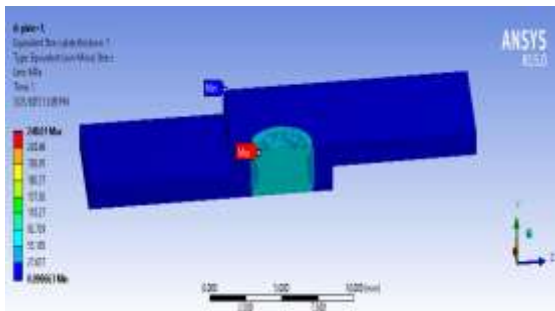


Figure:10 Equivalent stress at plate thickness is 1mm

The figure 10 are presents stress effect due to resistance spot welding.

Now the geometry will be checked for thermal stresses induced with application of electrode force and current.

	maximum deformation	Equivalent stress
Maxi. Result	0.0076mm	248.01Mpa
Min. result	0mm	0.090663Mpa

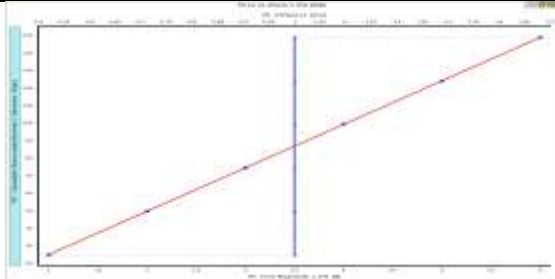


Figure:11 Force Vs Stress in 1mm plate

Figure: 11 represents a graph of defined force Vs equivalent stress for 1 mm plate thickness. Some range is given below for force, stress and thickness

Force: 1000 to 6000 N

Stress: 0 to 150 hbar

Thickness: 1 mm

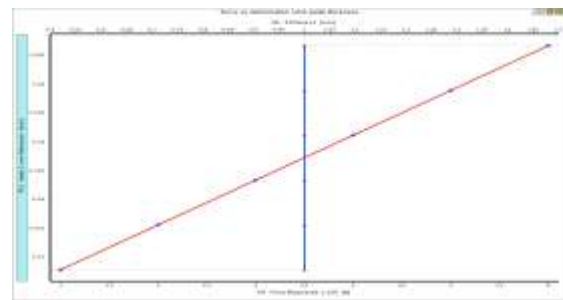


Figure:12 Force Vs Deformation in 1mm plate

Figure : 12 shows a relationship between electrode force and deformation which is linear in characteristic for applied conditions.

Some range is given below for force, stress and thickness

Force: 1000

Deformation: 0 to 0.5mm

Thickness: 1 mm

Figure 13 shows thermal effect on aluminum alloy 6082-T651 with Resistance spot welding process. The maximum and minimum temperatures obtained by thermal analysis are 550 C and 548.4 C which is closer to melting temperature of 555 C.

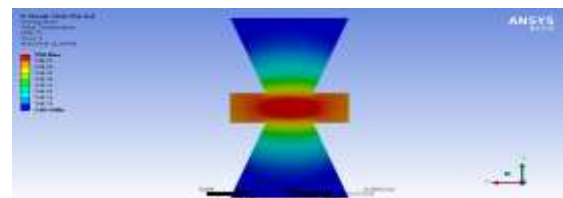


Figure:13 Thermal analysis results on 6082 T651

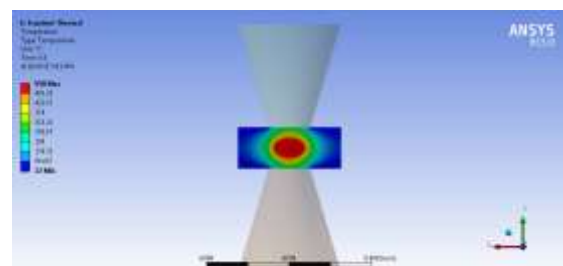


Figure:14 Temp Distribution

Figure 14 shows the temperature distribution during the resistance spot welding process for 6082 T651 aluminum alloy.

Step IV Conclusions

After the thermal analysis nugget generation was observed which is shown in Figure: 15.

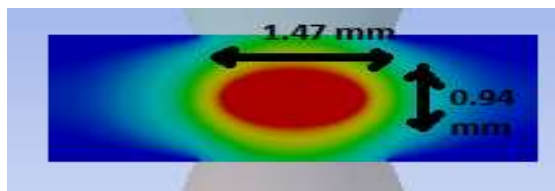


Figure: 15 Nugget analysis

It has been found the major and minor axis of nugget are 1.47mm and 0.94mm respectively. This is almost nearer to the values for material AA5754.

Resistance spot welding process is most significant joining process in the automobile industries due to high speed and suitable for automation. Any new development of this welding process is closely influence by the demanded of these industries. The RSW of aluminium alloy will ask for proper process parameters to increase its weld quality. Aluminium alloy 6082 T651 can be a suitable replacement of AA5754 for different application with good economy and strength. Thermal analysis shows that aluminium alloy 6082-T651 can be used for substitute of AA5754 aluminium alloy for reduction of cost of materials in automobile industry with the application of resistance spot welding process .

Some other observations from this work are under:

1. Successful weld spot was obtained after trial and error method for 1mm thickness.
2. As per the experimental investigation nugget diameter (major axis and minor axis of ellipse) was observed which is also in close proximity with nugget dimensions found in software analysis.
3. For 1mm plate thickness AA 6082 T651 satisfies the comparative criteria of AA5754 and hence it can be replace materia AA5754l in automotive industries.

FUTURE SCOPE:

The present work are only preliminary investigations for the weldability of AA 6082-T651.

The analysis can further be extended with different thickness of plates, different electrode forces, cycle time etc. To get optimize operating parameters to ensure required weld quality and strength with minimize cost and weight.

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