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Investigation of Mechanical Property of Friction Stir Welding Aluminum Alloy 6082

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***Abstract*- The present study involves the investigation of friction stir welding (FSW) of aluminum alloy 6082 to study the mechanical properties such as tensile strength and hardness. The two most important friction stir welding process parameter Tool rotating and welding speed are taken into the consideration. Study of tensile strength and hardness at different weld condition were carried out. The aim of this research study is to investigate the effect of different welding speed and tool rotating speed on the weld quality of AA6082 aluminum.**

Keywords—Friction stir welding; aluminum alloy 6082; Mechanical property; welding speed tool rotating speed; Tensile strength; Hardness

I. INTRODUCTION

Friction-stir welding (FSW) Friction stir welding (FSW) is a solid state joining process carried out with a non consumable rotating tool and is a Solid-state joining process (the metal is not melted) that uses a third body tool to join two facing surfaces. Heat is generated between the tool and material which leads to a very soft region near the FSW tool. It then mechanically intermixes the two pieces of metal at the place of the joint, then the softened metal (due to the elevated temperature) can be joined using

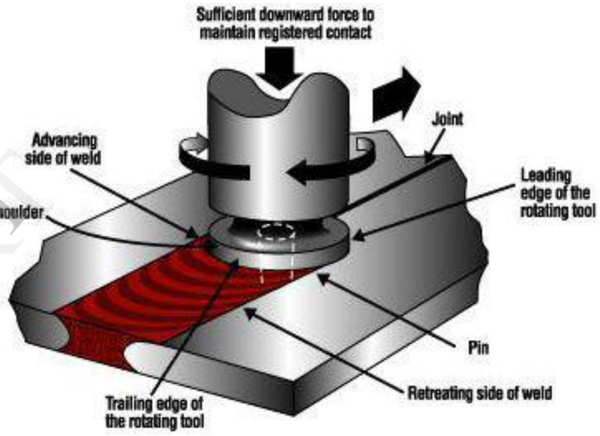
I. ALUMINUM ALLOY 6082

The 6082 is high strength Al-Mg-Si alloys that contain manganese to increase ductility and toughness. Aluminum alloy 6082 has the highest strength among the 6000 series alloys with excellent corrosion resistance property. Alloy 6082 is known as a structural alloy.

A) Applications

1. 6082 is typically used in
2. Highly stressed applications
3. Trusses
4. Bridges
5. Cranes
6. Transport applications
7. Ore skips
8. Beer barrels
9. Milk churns

mechanical pressure (which is applied by the tool), much like joining clay, or dough. It is primarily used on aluminum and most often on extruded aluminum (non-heat treatable alloys), and on structures which need superior weld strength.



C) CHEMICAL COMPOSITION

ELEMENT	% PRESENT
Manganese (Mn)	0.40 - 1.00
Iron (Fe)	0.0 - 0.50
Magnesium (Mg)	0.60 - 1.20
Silicon (Si)	0.70 - 1.30
Copper (Cu)	0.0 - 0.10
Copper (Cu)	0.0 - 0.20
Titanium (Ti)	0.0 - 0.10
Chromium (Cr)	0.0 - 0.25
Aluminium (Al)	Balance

II. EXPERIMENTAL WORK

A) FRICTION STIR WELDING

To carry out the FSW experiment a vertical milling machine was used. The tool was mounted in the vertical arbor using a suitable collate. The plates to be joined were clamped to the horizontal bed with zero root gap. The clamping of the test pieces was done such that the movement of the plates was totally restricted under both plunging and translational forces of the FSW tool. The tool rpm and translational speed of the bed were set prior to each run of welding. After plunging the rotating tool at the plate butt and visually ensuring full contact of the tool shoulder with the plate surface, the bed movement was done. A typical experimental FSW setup is shown in figure.

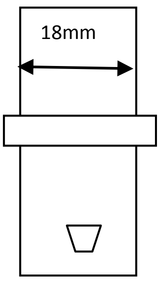
B) FSW PROCESS PARAMETER

In FSW, two parameters are important
1) Tool rotating speed.
2) Tool traverse speed/Welding speed.

The rotation of the tool results in stirring and mixing of the material around the rotating pin and traverse motion of the tool moves the stirred material from the front to the back of the pin and finishes welding process. Higher tool rotation rates generate higher temperature because of higher friction heating and results in more severe stirring and mixing of material. In addition to tool rotation rate and traverse speed, tool tilt is also an important process parameter. A suitable tool tilt of the spindle towards trailing direction ensures that the shoulder of the tool holds the stirred material and move material efficiently from front to the back of the pin.

C) FSW TOOL GEOMETRY

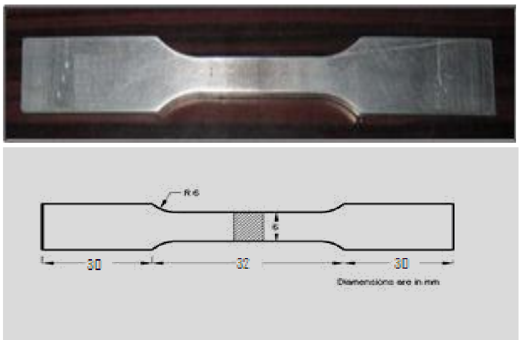
The tool geometry plays an important role in material flow and in turn decides the traverse rate at which FSW can be carried out. A FSW tool has two basic functions: (i) localized heating, and (ii) material flow. Understanding the tool design plays a very important role in friction stir welding. The initial FSW tool designed was a simple cylindrical tool with 18mm shoulder diameter. The chosen tool geometries and the fabricated tool for FSW of 5mm thick aluminum alloy are shown in Fig



Tapered tool H13 HSS
Tool Dia 18mm
Taper 6*3

D) SPECIMEN PREPARATION FOR TENSILE

The FSW welds cut according to the (American society for testing and materials) ASTM Specifications for tensile testing are shown in fig. The tensile testing of the welds was done using a UTM Machine and the tensile strength of the entire welded specimen are tabulated.



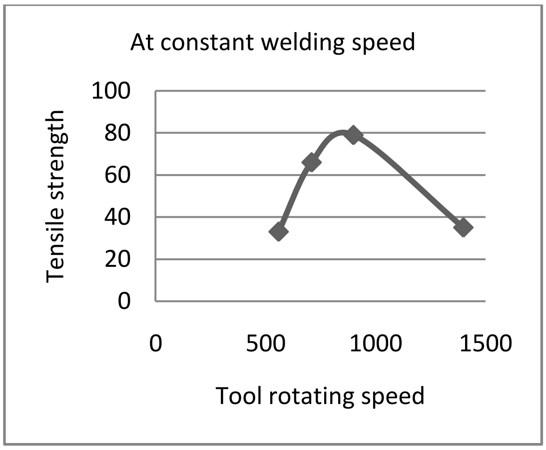
III. RESULTS AND DISCUSSION

A) Tensile strength

Tensile strength of the FSW joints was evaluated by conducting tests in universal testing machine. Tensile strength is the maximum load that a material can support without fracture when being stretched, Table shows the tensile strength of welded joints that has been tested.

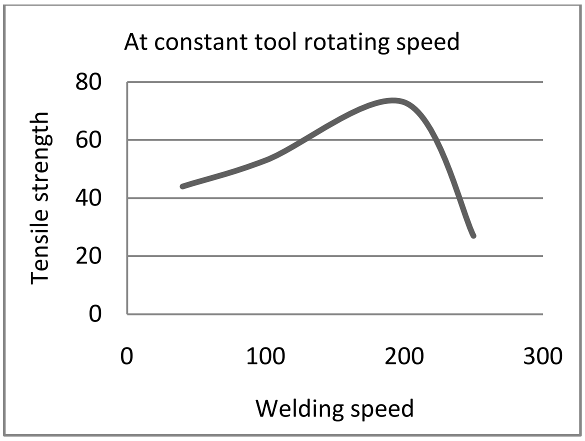
When welding speed is constant

Welding speed (mm/min)	***Tool rotating speed (rpm)***	***Tensile strength (MPa)***
200	450	70
200	560	33
200	710	66
200	900	79



When Tool rotating speed is constant

Tool rotating speed (rpm)	***Welding speed (mm/min)***	***Tensile strength (MPa)***
1120	40	44
1120	100	53
1120	200	73
1120	250	26.5

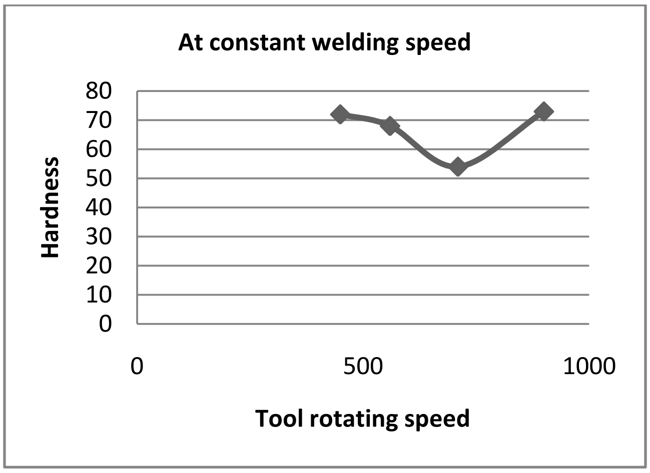


B) *Vickers Hardness tests*

The Vickers test is often easier to use than other hardness tests. The unit of hardness given by the test is known as Vickers pyramid number (HV). Hardness on welding spot is calculated and averages of three are taken. The hardness profiles are extremely useful, as they can assist in the interpretation of the weld microstructure and mechanical properties. The results of Vickers hardness (Hv) are shown in below tables.

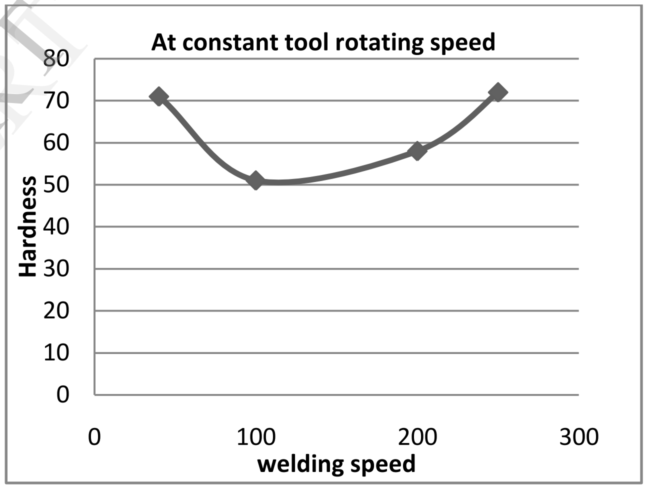
When welding speed is constant

Welding speed (mm/min)	***Tool rotating speed (rpm)***	***Vickers Hardness(HV)***
200	450	72
200	560	68
200	710	54
200	900	72.6



When tool rotating speed is constant

Tool rotating speed (rpm)	***Welding speed (mm/min)***	***Vickers Hardness(HV)***
1120	40	71
1120	100	51
1120	200	57.5
1120	250	70.3



IV. CONCLUSION

The following conclusion has been made from the above investigation

1. The tensile strength and Hardness of the Friction stir welded is affected by both the parameter welding and tool rotating speed.

- At constant welding speed 200mm/min

2. Highest tensile strength observed is 79Mpa at 900rpm. Tensile strength at the begging and end is low.
3. While hardness at lower and higher speed is more. And at optimum speed decreases.

- At constant tool rotating speed 1120rpm

4. At lower and higher tool rotating speed tensile strength is lower and is maximum at 200mm/min welding speed.
5. Hardness is more at lower and higher speed.

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