

Experimental Analysis on Friction Stir Welding of Aluminium Alloy 6082

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ABSTRACT: Friction stir welding is a solid state welding process used for welding similar and dissimilar materials. In the current work, friction stir welding is carried out on aluminium alloy AA6082. The friction stir welding process parameters such as tool rotation speed, tool travel speed play an important role in deciding the joining quality. These parameters are adjusted so that the interface is heated into the plastic temperature range where welding can take place. The work has been carried out to study the effect of process parameters like tool travel speed and tool rotation speed on the tensile strength of the weldments.

KEYWORDS: Friction Stir Welding, Process Parameters, Tensile Strength

I. INTRODUCTION

Friction stir welding is also a solid state welding processes; this remarkable upgradation of friction welding was invented in 1991 in The Welding Institute (TWI). In friction stir welding (FSW) a cylindrical, shouldered tool with a profiled probe is rotated and slowly plunged into the joint line between two pieces butted together. The parts have to be clamped onto a backing bar in a manner that prevents the abutting joint faces from being forced apart. Frictional heat is generated between the wear resistant welding tool and the material of the work pieces. This heat causes the latter to soften without reaching the melting point and allows traversing of the tool along the weld line. The maximum temperature reached is of the order of 80% of the melting temperature of the material. The plasticized material is transferred from the leading edge of the tool to the trailing edge of the tool probe and is forged by the intimate contact of the tool shoulder and the pin profile. It leaves a solid phase bond between the two pieces. The process can be regarded as a solid phase keyhole welding technique since a hole to accommodate the probe is generated, then filled during the welding sequence.

The advantages of FSW technique is that it is environment friendly, energy efficient, there is no necessity for gas shielding for welding Aluminium. Mechanical properties as proven by fatigue, tensile tests are excellent. There is no fume, no porosity, no spatter and low shrinkage of the metal. Joining dissimilar and previously unweldable metals can be attempted by this unique process.

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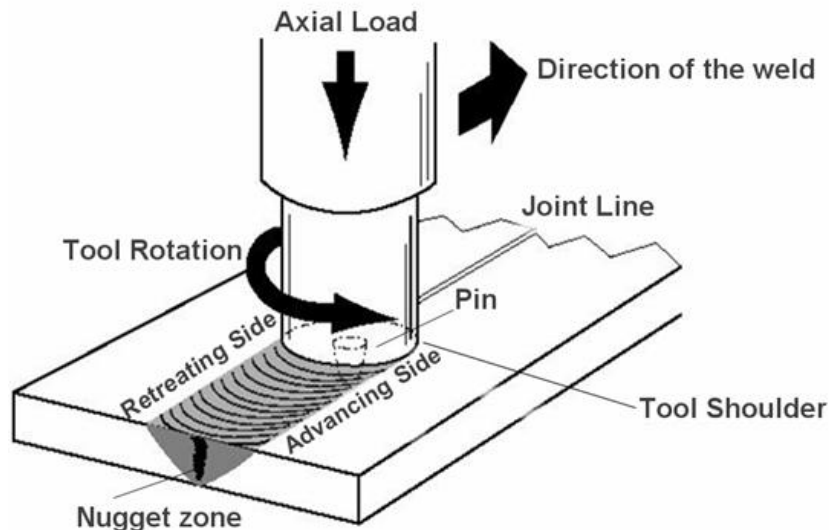


Figure 1 Schematic diagram of FSW process

Figure 1 show briefly about friction stir welding process and process parameters involved during friction stir welding process like axial load, tool rotation and direction of weld etc.

II. LITERATURE REVIEW

Amancio-Filhoa et al. (2007) described that aircraft Aluminium alloys generally present low weld ability by traditional fusion welding process. The development of the friction stir welding has provided an alternative improved way of satisfactory producing Aluminium joints, in a faster and reliable manner.

Riahi (2010) in this research residual stress is lower in friction stir welding (FSW) compared with other melting weldment processes. This is due to being solid-state process in its nature. There are several advantages in utilizing stir welding process. Lower fluctuation and shrinkage in weldment metal enhanced mechanical characteristics, less defects, and ability to weld certain metals otherwise impractical by other welding processes are to name just a few of these advantages. In the prediction of results of residual stress, only heat impact was studied. This was recognized as the main element causing minor difference in results obtained for simulation in comparison with that of actual experiment.

Liu a (2013) In their research, the 4 mm thick 6061-T6 Aluminium alloy was self-reacting friction stir welded at a constant tool rotation speed of 600 r/min. The specially designed self-reacting tool was characterized by the two different shoulder diameters. The results of transverse tensile test indicated that the elongation and tensile strength of joints increased with increasing welding speed. The defect-free joints were obtained at lower welding speeds and the tensile fracture was located at the heat affected zone adjacent to the thermal mechanically affected zone on the advancing side.

III. EXPERIMENTAL WORK

The 6xxx alloys are heat treatable, and have moderately high strength coupled with excellent corrosion resistance. They are readily welded. A unique feature is their extrudability, making them the first choice for architectural and structural members where unusual or particularly strength- or stiffness-criticality is important.

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The chemical composition of AA6082 is shown in Table 1. All the elements are shown with percentage wise. The major elements involved in AA6082 are silicon, ferrous, copper, manganese, magnesium, zinc, titanium and chromium.

Element	% present
Si	0.7 – 1.3
Fe	0.0 – 0.5
Cu	0.0 – 0.1
Mn	0.4 – 1.0
Mg	0.6 – 1.2
Zn	0.0 – 0.2
Ti	0.0 – 0.1
Cr	0.0 – 0.25
Al	Balance

Table 1: Chemical composition of AA6082

In present experiment we select 4mm thickness of Aluminium sheet. Aluminium sheet was cut with the dimensions of 4mmx70mmx100mm using shearing machine and the edges of the plate are filed to get smooth surface finish. After the plates are cut into required sizes, fix the plates side by side on work table rigidly by clamps to form butt joint. The tool material selected for this experiment is H13 Tool Steel due to its excellent combination of high toughness and fatigue resistance. Tool profile is threaded pin profile.



Figure 2 Experimental set up and weld pieces

Figure 2 shows the experimental set up on CNC milling machine. The aluminium alloy work pieces are rigidly clamped on work table. By using Tool with a threaded pin profile experiment is done with the combination of welding process parameters. After welding the weld pieces are shown in figure.

Table 2 shows the combinations of process parameters, friction stir welding experiment were done on CNC Vertical Milling Machine. By following the sequence in below table we do experiment one by one. The speed and feed (Tool Travel Speed) are increased with specified incremental rate.

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Specimen Number	Speed (RPM)	Feed (mm/minute)
01.	750	50
02.	750	100
03.	1000	50
04.	1000	100
05.	1250	50
06.	1250	100

Table 2: Process parameters for FSW

IV. EXPERIMENTAL RESULTS

The weld pieces are subjected to tensile tests on a universal testing machine to evaluate the strength of welded joints. The weld pieces are prepared as per ASTM E8/E8M standard.

The results of tensile test which were observed during the experiment were tabulated which are shown in below table 3. Increase in rotational speed has resulted in increase of tensile strength. Primary reason is, the higher the speed, the higher will be the deformation and heat generation in the weld. This will result in finer grain structures, because of which tensile strength is increases.

Specimen Number	Speed (RPM)	Feed (mm/minute)	UTS (Mpa)
01.	750	50	112.1
02.	750	100	130.0
03.	1000	50	139.0
04.	1000	100	145.3
05.	1250	50	145.7
06.	1250	100	152.4

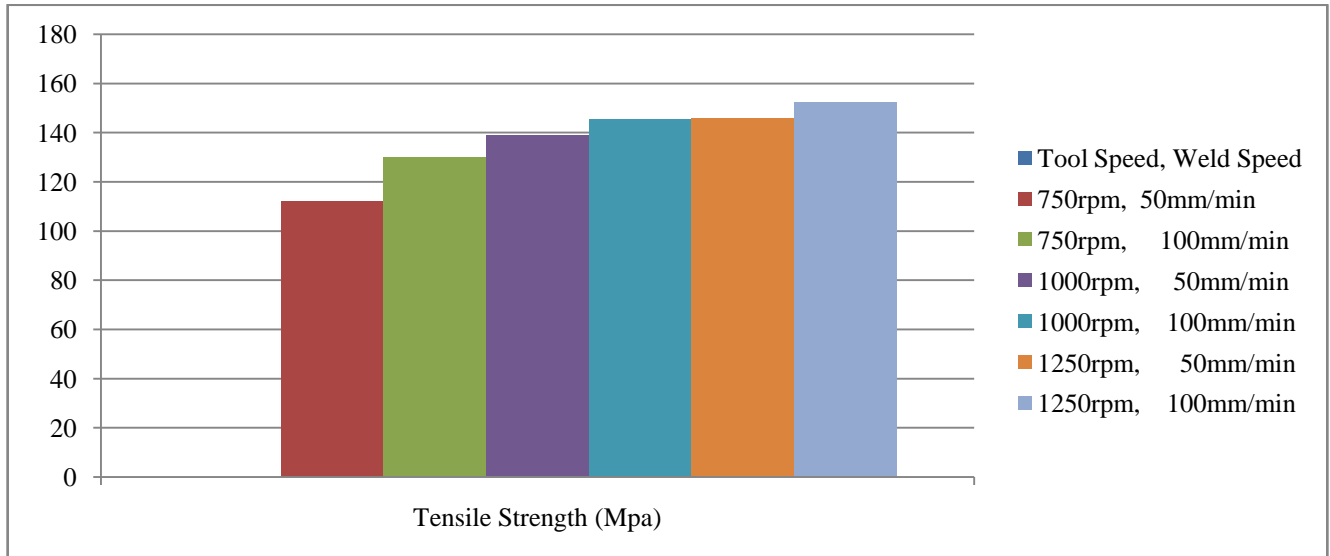
Table 3: Ultimate Tensile Strength Results

Table 3 shows the ultimate tensile test results coming from tensile test done on universal testing machine. With increasing tool speed and tool travel speed the ultimate tensile strength is increased. Also with increasing tool speed and tool travel speed the surface finish is increased.

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Graph 1: Graphical Representation of Tensile Test Results

V. CONCLUSION

The following conclusions can be drawn from present study

1. Tensile strength is found to increase with increase in rotational speed and weld speed. Maximum Tensile strength of 152 Mpa was observed at 1250 rpm (for 100 mm/min feed). This indicates that for AA6082 Al Alloys, higher range of rotational speed is best suited to achieve maximum tensile strength.
2. Surface finish is increased by increasing tool rotation speed and tool travel speed.

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