STUDY OF MECHANICAL PROPERTIES OF FRICTION STIR WELDED JOINT OF SIMILAR ALUMINIUM ALLOY (AL-2024-T3)

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Abstract - *Friction stir welding has a primary and wide application in boat building industries, aviation, vehicles and many assembling commercial enterprises. Procedure demonstrates the welding of a non-heat treatable or powder metallurgy Al composites, to which the fusion welding can't be connected. Friction stir welding is a new found solid state joining process. This joining strategy is essential productive, environment friendly, and adaptable. Basically, it can be used to join high-quality Al compounds and other combinations that are difficult to weld by traditional fusion welding. A brief overview of the friction stir welding process and the friction stir welding of the AL alloy is presented in this paper. In addition, a composite picture of the work done, relating to the mechanical properties and micro structural developments in a friction stir welded of Al 2024 alloy is presented.*

Key Words: Friction stir welding, AA 6061, AA 2024 T_3, EN9 material, Uni-axial Tensile testing Machine, Transverse speed, Rotational speed

1. INTRODUCTION

Friction stir welding has a primary and wide application in boat building industries, aviation, vehicles and many assembling commercial enterprises. Procedure demonstrates the welding of a non-heat treatable or powder metallurgy Al composites, to which the fusion welding can't be connected. Friction stir welding is a new found solid state joining process. This joining strategy is essential productive, environment friendly, and adaptable. Basically, it can be used to join high-quality Al compounds and other combinations that are difficult to weld by traditional fusion welding. It is basically used on, Al and frequently on extruded Al (non-heat treatable composites), and on structures which need high weld quality without a post weld heat treatment.

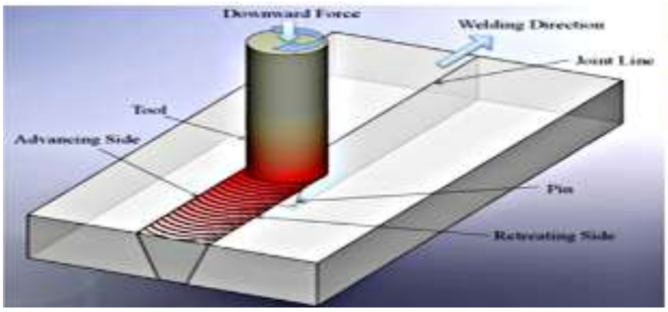

Fig -1.1: Working principle of a FSW process

The working principle of Friction Stir Welding procedure is shown in figure 1.1. A welding apparatus consisted a shank, shoulder, and pin is inserted in a milling machine chuck and is turned about its longitudinal hub. The work piece, with square mating edges, is fixed to a rigid backing plate, and a clamp is provided to keeps the work piece from vibrating or lifting it the time welding operation. The half-plate where the heading of revolution is the same as that of welding is known as the advancing side, with the other side assigned just like the retreating side.

Fig -1.2: FSW process (Arrangement of workpiece and tool)

Figure 1.2 showing an arrangement of work-pieces are fixed together as Butt joint by help of fixtures with specially designed grooves with adjustable space for tightening the plates. During operations the fixed plates may be gets heavily vibrations from axial force and get loosen its bolt and arrangement, so before start the operation tightening and fixing of work- piece properly on the table. Also figure 1.2 showing an arrangement of tool with tool holder and also the fixture designed and used to hold the work piece rigidly is shown. Figure 1.4 have been shown that the welded plates at different speed, which is ranging from 710 rpm to 1000 rpm. Total 4 experiment did, by varying its feed from 40mm/min to 80mm/min .At 1000 rpm, two welding have been processed with varying feed parameter and at 710 rpm, and two welding have been processed with varying feed parameters.

The experiment is conducted for EN9 material with varying tool rotational speed (rpm) and transverse speed (mm/min) by using the universal milling machine as shown in the Figure 1.3.

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June-2018 www.irjet.net p-ISSN: 2395-0072

Fig -1.3: Universal milling machine

Table -1: Processing parameters for EN9 material

Exp No	Tool rotational speed (rpm)	Tool traverse speed (mm/min)	Tool offset	Tool materials
1	710	40	0.5	EN9
2	710	80	0.5	EN9
3	1000	80	1	EN9
4	1000	40	1	EN9

Fig -1.4: Welded AA 6061 plates

Figure 1.4 shows the welded aluminium plates, using these plates, 15 mm strips are prepared and used for tensile and bending tests.

2. FUNDAMENTAL MECHANICAL TESTS

2.1 Tensile test

The tensile specimens are prepared according to the ASTM standards using the universal milling machine. Figure 2.1 shows the typical tensile test specimens prepared.

Fig -2.1: Tensile test specimens

The tensile test is conducted using the Uni-axial Tensile testing (UTM) Machine shown in figure 2.2. It is computer integrated machine where which gives the results itself so there is no need of calculating the results theoretically.

Fig -2.2: Uni-axial Tensile testing Machine (UTM) setup

Table -2.1: Processing parameters of tensile test

Test sample	Traverse speed in mm/min	Break load (KN)	UTS (MPa)	% of Break Displacement
Exp-1	710	40	36.259	6.314
Exp-2	710	80	87.793	10.149
Exp-3	1000	40	161.817	13.747
Exp-4	1000	80	42.011	13.068

2.2 Bending test

The bending test is performed using the Universal testing machine as shown in the figure 2.3. The 15 cm strips are prepared from the welded joint and used for bending test.

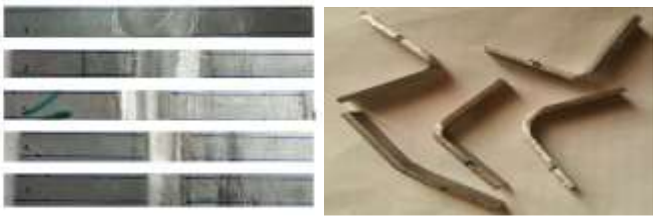

Fig -2.3: Bending test specimens before and after test

Fig -2.4: Universal testing machine

Table -2.2: Processing parameters of bending test

Expt No	Traverse speed (mm/min)	Peak load In KN	Ultimate compressive strength in MPa
1	40	0.18	2.10
2	80	0.3	3.84
3	40	2.16	28.48
4	80	0.24	2.82

3. RESULTS AND DISCUSSIONS

In the below figure 3.1 it is shown that the maximum ultimate compression strength is found in the exp 3 which as a traverse speed of 40 mm/min and a rotational speed of 1000 rpm form the above obtained results and the graphs it can be said that maximum compression strength is obtain at a lower traverse speed and high rotational speed .The bending strength value of the welded metal found to be 35to 40 percent of the base metal. When the traverse speed is 40 mm/min and rotational speed is 1000 rpm the maximum tensile strength is achieved due to during the lower traverse speed heat generated is high due to high friction. So from this, the tensile strength value is high by decreasing the traverse speed and increasing the rotational speed.

In the above results and graph it also shows that exp 1 having rotational speed 710 rpm and traverse speed of 40 mm/min will have less bending strength when compared to others which means with less rotational speed and less feed rate the tensile strength of the welded joint decreases.

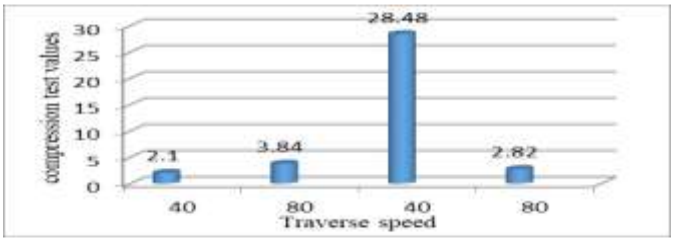

Fig -3.1: Effect of varying transverse speed on compression property of AA 2024 T_3

In the below figure 3.2 it can be seen that maximum ultimate tensile strength optioned is found in the exp 3 which provided with a traverse speed of 40 mm/min and rotational speed of 1000 rpm form the above obtained results and the graphs it can be said that maximum tensile strength is obtain at a lower traverse speed and high rotational speed The tensile strength value of the welded metal found to be 35to 40 percent of the base metal. When the traverse speed is 40 mm/min and rotational speed is 1000 rpm the maximum tensile strength is achieved due to during the lower traverse speed heat generated is high due to high friction. So from this, the tensile strength value is high by decreasing the traverse speed and increasing the rotational speed.

In the above results and graph it also shows that exp 1 having rotational speed 710 rpm and traverse speed of 40 mm/min will have less tensile strength when compared to others which means with less rotational speed and less feed rate the tensile strength of the welded joint decreases.

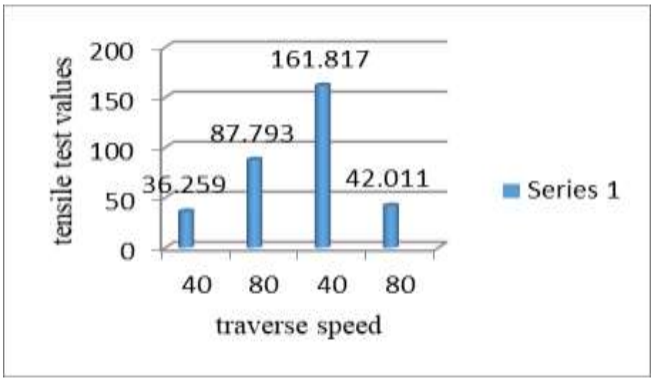

Fig -3.2: Effect of varying transverse speed on tensile property of AA 2024 T_3

4. CONCLUSION

- Friction stir welding of AA 6061 is successfully performed at different rotational and different traverse speeds.
- The tool rotational speed is in between 710 and 1000 rpm is the maximum given input to obtain a good weld through FSW process and successfully formed AA 2024-T3 composite. A welding speed of 40 mm/min is most compatible.
- From the results and graphs it is shown that the maximum UTS is found in the exp 3 which as a traverse speed of 40 mm/min and a rotational speed of 1000 rpm, from the above obtained results and the graphs it can be said that maximum tensile strength is obtain at a lower traverse speed and high rotational speed. The tensile strength value of the welded metal found to be 35 to 40 percent of the base metal.
- From the results the traverse speed directly effects on the friction stir welding process.

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