TENSILE BEHAVIOUR FOR ALUMINIUM ALLOY (6061) IN SINGLE & DOUBLE PASS FRICTION STIR WELDING BY USING DIFFERENT TOOL SHAPES

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ABSTRACT

In this experimental work, an extensive investigation had been carried out on Al Alloy(6061). In this work the speed of tool rotation were taken as 3080 rpm, transverse speed as 30mm/min. and tool tilt angle was taken as 2^0*. In both single and double pass, the highest tensile strength of the joints was obtained by using the square pin profile tool. The square pin profiles tool is best and tensile strength significantly decreases for, cylindrical, triangular and threaded pin profile tool due to defect formation. In double sided weld, the joints fabricated by cylindrical pin profiled tool showing almost matching tensile properties to that of square pin tool profile.*

Keywords: *Al-Alloy (6061), High Carbon Steel Tool, Tensile Behavior.*

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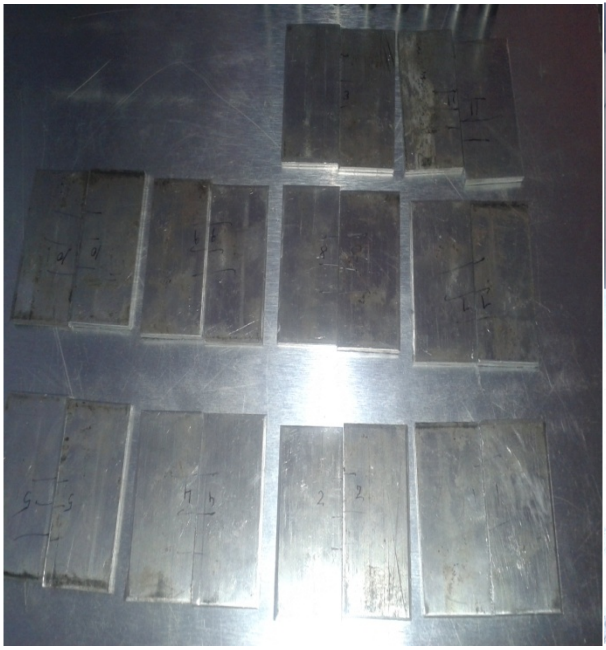
INTRODUCTION

The welding of the material is facilitated by severe plastic deformation in the solid state involving dynamic recrystallization of the base material. General convection is, where the direction of the velocity vector of the tool and traverse direction are same that side is called the advancing side of the weld, and when the direction of the velocity vector opposite to the traverse direction, it is called the retreating side. The welding equipment can be a conventional milling machine which instead of a milling tool carries a welding tool. The thickness of the aluminum material being welded is between 1.5-30 mm. In aluminum alloys, the solid state weld formation produced by friction stir welding provides three important metallurgical advantages when compared to fusion welds. First, joining in the solid state eliminates cracking often associated with fusion welding processes, e.g., liquidation or solidification cracking. Second, there is no loss of alloying elements through weld metal evaporation and the alloy composition remains unchanged. Finally, the plastic deformation and forging action of the welding tool produces a weld metal with a finer grain structure than the base metal **.**In aluminum alloys, the mechanical properties of friction stir welds are usually better than those produced by conventional gas metal arc welding. Most of the work in friction stir welding has been done on aluminum alloys, where the mechanical properties were near those of the base plate. A number of potential advantages of FSW over conventional fusion-welding processes have been identified

WELDING PARAMETERS

1. Tool rotation and traverse speeds
2. Tool tilt and Plunge depth
3. Tool design
4. Welding forces
5. Generation and flow of heat

PICTURE OF AL-ALLOY **TOOL USED FOR SET UP**



PROCEDURE

For this firstly AA6061material blank is pressed in a press to make it straight and stress free. After that from this material blank, thirteen plates of size 100x50x6mm are cut on shaper machine as shown in figure. After cutting plates of proper size, then the edgesof these plates are made straight by passing cutting tool at angle 90^0 simultaneously on all the pieces. Then these plates are made burr free by filing so that when two plates are kept in fixture simultaneously for friction welding, then there should not be any gap present between two pieces in order to make better samples for friction welding. In this work the tool rotation speed kept constant at 3080 rpm, transverse speed was 30mm/min. and tool tilt angle was taken 20.Tool tilt angle given to provide required pressure in the welding.

TENSILE TESTING

Tensile testing, also known as tension testing, is a fundamental material science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. A tensile specimen is a standardized sample cross-section. It has two shoulders and a gauge (section) in between. The shoulders are large so they can be readily gripped, whereas the gauge section.

SPECIFICATION OF UTM

Machine Model	1979
Make	FIE
Range	0-20 KN
Testing temperature	Room temperature

RESULTS

The maximum and minimum ultimate tensile strength in this experimental run is 91N/mm^2 and 77N/mm^2 respectively in double pass. The maximum and minimum ultimate tensile strength is 85N/mm^2 and 75N/mm^2 respectively in single pass. The joints fabricated by single pass have shown lower tensile strength and lower percentage of elongation compared to the joints fabricated by double pass and this trend is common for all the tool profiles. The joints fabricated by threaded pin profile tool in single sided weld shown inferior joint efficiency due to crack formation.

Results of welded specimen in single pass

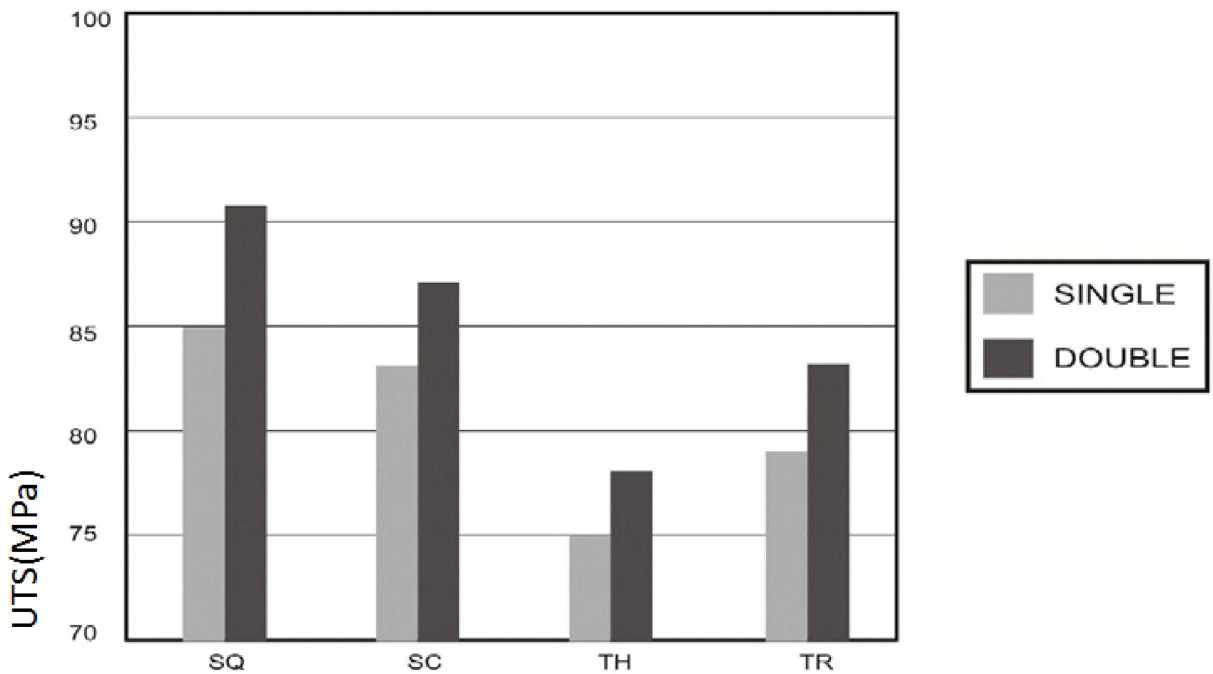
Specimen No.		Ultimate Tensile Strength		Percentage Elongation		Joint Efficiency (%)
	Area (mm^2)	Load (kgf)	Stress (N/mm^2)	Elongated Length (mm)	% Elongation	
S1	144	1248	85	55.30	9.5	65.3
S2	142.8	1208	83	54.25	7.8	63.8
S3	144	1104	75	53	5.6	57.6
S4	142.2	1148	79	54.10	7.5	60.7

Tensile testing Results of welded specimen in double pass

Specimen No.		Ultimate Tensile Strength		Percentage Elongation		Joint Efficiency (%)
	Area (mm^2)	Load (kgf`)	Stress (N/mm^2)	Elongated Length (mm)	% Elongation	
S5	139.2	1292	91	55.45	9.8	70
S6	144	1280	87	55.38	9.7	66.90
S7	144.6	1132	77	54.20	7.7	59.23
S8	143.1	1208	83	55.20	9.4	63.8

Specimens before Failure of Welded Specimen in Tensile Test

Specimen after failure under tensile testing



Variation of Ultimate Tensile Strength

CONCLUSIONS

Higher ultimate tensile strength and also higher percentage of elongation Square pin tool having superior joint efficiency. The single sided weld inferior joint efficiency due to crack formation. The double pass weld has higher ductility.

REFERENCES

1. Dequing, W., Shuhua, L. and Zhaoxia, C., (2004), "Study of friction stir welding of aluminum", *Material Science and Engineering Journal*, Vol. 39, No. 5, pp. 1689-1693.
2. Lorrain, O., Favier, V., Zahrouni, H. and Lawrjaniec, D., (2010), "Understanding the material flow path of friction stir welding process using unthreaded tools", *Journal of Materials Processing Technology*, Vol. 210, No. 4, pp. 603–609.
3. Moreira, P., Oliveira, F.M.F. and Castro, P.M.S.T., (2008), "Fatigue behaviour of notched specimens of friction stir welded aluminium alloy 6063-T6", *Journal of Materials processing technology*, Vol. 207, No. 1-3, pp. 283–292.
4. Colligan, K., (2004), "Material flow behavior during friction stir welding of aluminum", *Materials Research*, Vol. 78, No. 7, pp. 229-237.

5. Kim, D., Badarinarayan, H., Hoon, J., Kim, C., Kazutaka, O., Wagoner, K. and Chung, Y., (2010), "Numerical simulation of friction stir butt welding process for AA5083-H18 sheets", *European Journal of Mechanics A/Solids*, Vol. 29, No. 2, pp. 204–215.
6. Sato, Y.S., Kokawa, H., Enomoto, M. and Jogan, S., (1999), "Microstructural evolution of 6083 aluminum during friction stir welding", *Metallurgical and Materials Transactions*, Vol. 44, No. 1, pp. 2429-2433.
7. Stefano, M. and Chaired, S., (2008), "Corrosion resistance in FSW and in MIG welding techniques of AA6XXX", *Journal of Materials processing technology*, Vol. 197, No. 1-3, pp. 237–240.
8. Woo, W., Chooa, H., Donald, B., Feng, Z. and Liawa, P. K., (2006), "Angular distortion and through-thickness residual stress distribution in the Friction-stir processed 6061-T6 aluminum alloy", *Materials Science and Engineering Journal* Vol. 437, No. 1, pp. 64–69.
9. Yon, Y., Tong, Z. and ZHANG, W., (2010), "Dissimilar friction stir welding between 5052 aluminum alloy and AZ31 magnesium alloy", *Trans. nonferrous met. Soc. China*, Vol. 20, No. 2, pp. 619-623.
10. Zheng, L., Petry, D. and Rapp, H., (2008), "A characterization of material and fracture of AA6061 butt weld", *Thin-Walled Structures*, Vol. 47, No. 4, pp. 431-441.
11. www.indiabizsource.com, images downloaded on 10.01.2014
12. Garg, S.K., (2006), " Workshop Technology", *Laxmi Publications (P) LTD*, Vol. 1, No. 5, pp. 98.