International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 12 | Dec -2016 www.irjet.net p-ISSN: 2395-0072

Experimental investigation and effect of welding speed on the tensile properties of friction stir welding AA7075 AL. Alloy.

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Abstract: *Now a days Friction stir welding (FSW) is used for many emerging applications,including ship building ,aerospace ,and transportation industries.This project focuses on the tensile behavior of joining of similar of AA 7XXX alloy produced by friction stir welding .Suitable FSW tool will be manufactured and five different welding speeds 20mm/min,30mm/min,40mm/min,50mm/min,and 60 mm/min)will be used to weld the joints .Tensile specimen were prepared as per the ASTM standard parallel to the welding speed direction .Effect of welding speed on the tensile properties will be analyzed and suitable welding speed for maximum tensile strength will be identified.*

Keywords:*Friction stir welding ,Response surface methodology,Tool materials,Tensile test.*

1.INTRODUCTION

Grain size of the welding joints are studied.Rotational speed and welding speed of friction stir welding is studied. Mechanical properties of welding joints are studied.Optimized tensile properties of this project is studied

2.LITERATURE SURVEY

Shubham patel et.al.(Jan 2016), Above researcher conduct experiments on experimental investigation of friction methodology. **Saksham Dhanjal et.al (2016),** Above researcher conduct experiments on effect of process parameters on weld Alloys **.** Optimized parameters for the FSW of AA2014 and AA7075 aluminium alloy are found to be 1400RPM,80mm/min travel speed with square tool. **G.Venkateswarlu et. al(2016),** Above researcher conduct experiments on simulation studies of friction stir welded Aluminium 7075Alloy **P.Srinivasulu et.al (march 2015),** Above researcher conduct experiments on experimental investigation of mechanical properties of friction stir welded AA6082 Aluminum Alloy Butt joints. Maximum tensile strength is 103.4N/mm^2 in Joint number 4 with a spindle speed of 1800Rpm,travel speed 50mm/min & plunge speed is 20mm/min.**Research Gap:** Above researcher is not done with maximum tensile strength (164.5MPa) is achieved in 900Rpm of rotational speed and 20mm/min of welding speed and not researched over increase the rotational speed for fixed welding speed or increasing welding speed for fixed rotation speed .

3.EXPERIMENTAL DETAILS

3.1 FSW MACHINE SPECIFICATIONS:

Fig-1: Friction stir welding machine

Table-1: Friction stir welding machine specifications

X-Axis	1m to 100m or more upto 5000mm/min velocity,servo controlled
Y-Axis	1 meter standard
Z-Axis	600mm stroke,force or position controlled 50kNaxial force
Tilt	+/-5 degrees
Spindle	15KW (20Hp)vector drive various speed and torque combinations available
Rotary table axis	Available as an option
Control	Force or position control modes full data acquisition system

3.2 MATERIAL REQUIREMENTS:

In this project we are taken Aluminium Alloy AA7075 for fabrication of friction stir welding .Two metal plates are taken with 100mmx50mmx6mm size,and the two plates are clamped rigidly by clamps and bolts in the Vice.

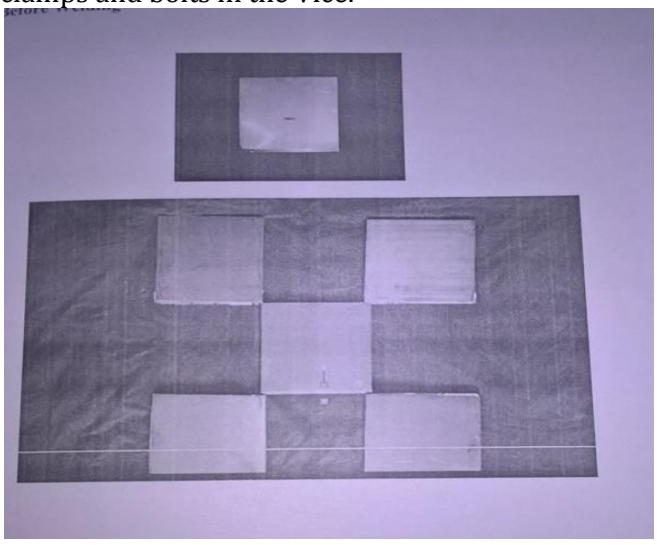

Fig-2: Before welding

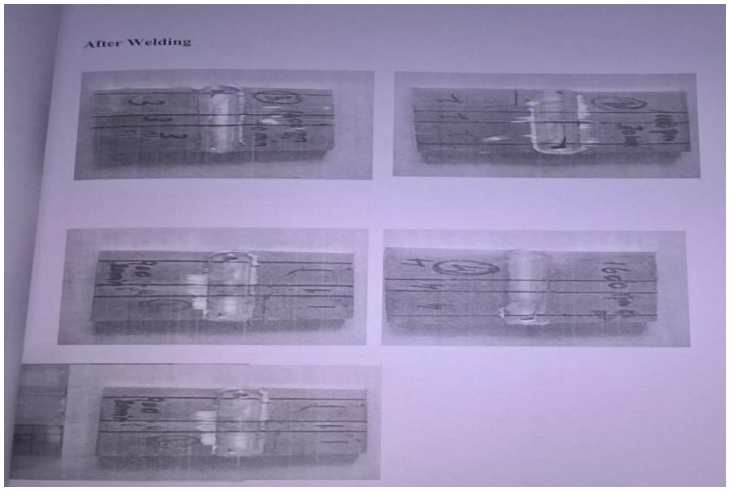

Fig-3: After welding

Table-2: Mechanical properties of Aluminium alloy

Property	Value
Atomic Number	13
Atomic Weight (g/mol)	26.98
Melting point(^{0}C)	660.2
Boiling point(^{0}C)	2480
Mean specific heat(0-100^{0}C)cal/g^{0}C	0.219
Thermal conductivity(0-100^{0}C)cal/cms^{0}C	0.57
Thermal expansion co-efficient (x10^{-6}/k)	20.4
Co-efficient of Linear Expansion (0-100^{0}C)x10^{-6}/^{0}C	23.5
Electrical Resistivity at 20^{0}C(μΩcm)	2.69
Density(g/cm^3)	2.6898
Modulus of elasticity(Gpa)	68.3
Poisson's Ratio	0.34

Elastic Modulus(Gpa)	70
Tensile strength(Mpa)	230
Yield strength(Mpa)	215
Percent Elangation(%)	10

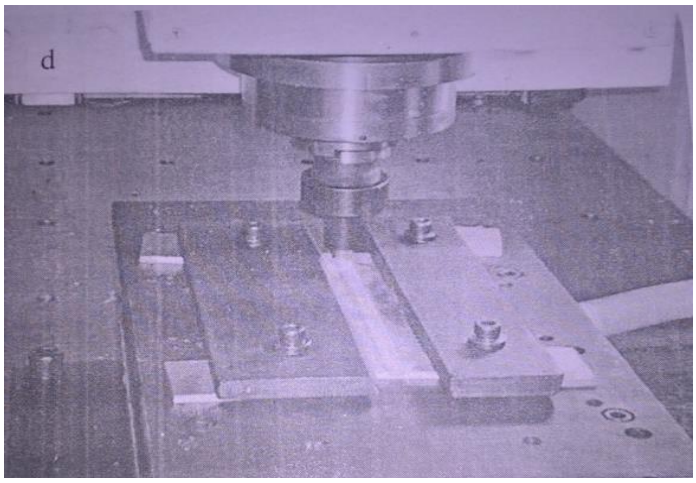

Fig-4.Friction stir welding Process

Table.3. Friction stir welding parameters

Parameters	Values
Rotational speed(Rpm)	900,1000,1200,1400,1600 Rpm
Welding speed(mm/min)	20,30,30,40,50min/min
Tilt Angle(^{0}C)	1,2,3,4,5 Degree
Tool Material	High speed Tool steel(M2)
Tool pin profile	Conical
Pin Diameter	6mm
Shoulder Diameter(mm)	18mm
Axial Force	6,7,8,9&10

4.METHODOLOGY

Fig-5.Sequence of Field work

- The FSM technique has high joining speed,autogenous welding in comparison wit conventional fusion welding methods.
- Material flow behavior depends on the action of rotating tool.
- From reported primary and secondary process parameters ,(Fig.9)which contribute to heat input and subsequently influences TS(Traverse speed) variations in FSW aluminium alloy joints were selected for this study.

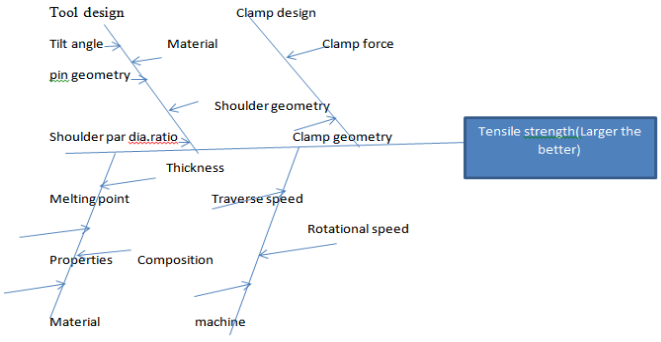

Fig-6.Cause & effect diagram of

FSW joint process

- The rapid development and implementation into commercial applications has motivated its application to other nonferrous materials (Mg,Cu,Ti)
- Steel is in the identification and development of suitability.
- Plates of AA7075 alloy (6mm thick)to find out feasible working limits of FSW process parameters.

5. RESULT AND DISCUSSION

5.1 MICRO STRUCTURE ANALYSIS

The solid state nature of the FSW process combined with its microstructure.The microstructure can be broken up .

- Recrystallised zone is a region of heavily deformed material .
- The grains within the stir zone are roughly equiaxed .
- A unique feature of the stir zone has been referred to as an "onion-ring"structure.
- Texture have all been suggested.

Fig-7.Micro structure

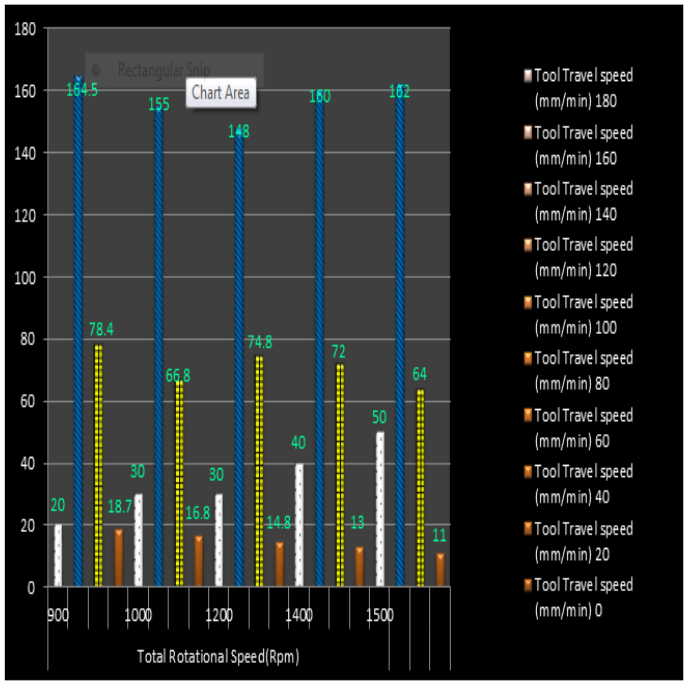

Fig-8.Graph for UltimateTensile Strength

Table.4. Tensile properties of Aluminium 7075

S.NO	Tool Rotational Speed(Rpm)	ToolTravel Speed (mm/min)	UTS(MPa)	YS(MPa)	Elongation(%)
1	800	10	158	67.2	15.2
2	**900**	**20**	**164.5**	**78.4**	**18.7**
3	1000	30	155	66.8	16.8
4	1200	30	148	74.8	14.8
5	1400	40	160	72	13

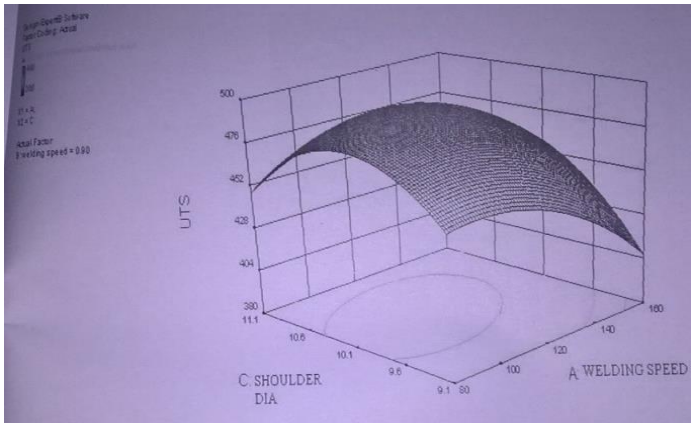

Fig-9.Response graphs for tensile strengthof AA7075Aluminium alloy friction stir welded joints

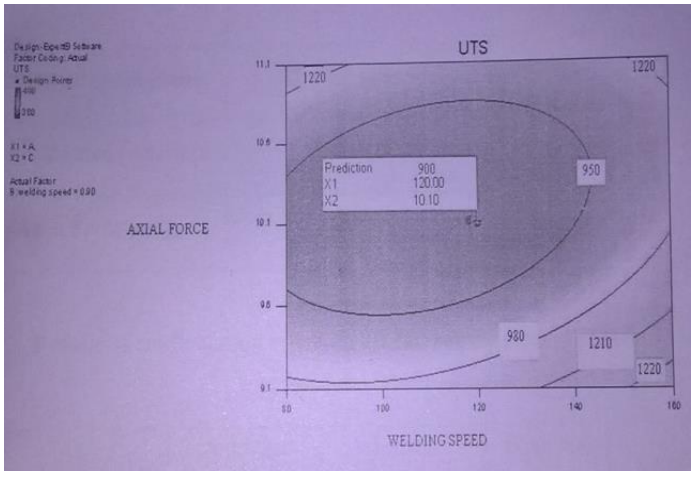

Fig-10.Contour plots for Tensile strength of AA7075 Aluminium alloy friction stir welded joints

Table.5. Optimized process parameters for welding of Aluminium alloy 7075

Process parameters	Optimized Values	Tensile strength(MPa)
Rotational speed(Rpm)	900Rpm	164.5
Welding speed(mm/min)	20mm/min	
Axial Force(KN)	6KN	

Table.6. Results of confirmation experiments for Tensile strength(Mpa)

Process parameters	Optimized Values	Tensile strength(MPa)	Predicted Value(MPa)	Error %
A=Rotational speed(Rpm)	900Rpm	164.5	165	0.5
B=Welding speed(mm/min)	20mm/min			
C=Axial Force(KN)	6KN			

- Response surface methodology(RSM)was used to optimize then Friction stir welding of Aluminium Alloy AA7075 process parameters to attain maximum tensile strength .
- Optimized values were closely matching with the experimentally determined values.
- The response graphs and contour plots were found to be beneficial to analyze the effect of main and interaction factors on responses.
- The developed regression equations are capable of predicting optimum welding parameters for obtaining quality weld.

6. CONCLUSIONS

In (WNZ)Weld nugget zone of all the joints of the grains in the middle part posses larger size than those in upper and lower parts.

Rotational speed or welding speed increase upto a high value void defect is formed.

Increase the rotational speed for fixed welding speed or increasing welding speed for fixed rotation speed.

Tensile property is increased first and decrease due to the occurrence of weld defect.

Maximum tensile strength (164.5MPa) is achieved in 900rpm of rotational speed and 20mm/min of welding speed.

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