Assessment of Mechanical properties of welding of Al 6061 By Friction Stir Method and Metal Matrix Composites

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Abstract : This paper depicts about the FSW process carried out on Aluminium 6061and it shows that various different kinds of factors of welding like speed of transverse, speed of rotation etc. Various mechanical properties of welded aluminium joints are anaylsed like hardness, tensile strength and microstructure. Metal matrix composites are also studied widely as diverse fields and they depict enhanced mechanical properties when compared with matrix alloy The properties of composites are utilized to make high end materials

Keyword **–R&D, Quality Function Deployment (QFD), Friction stir welding, AA6061 and Aluminum Alloy.**

I. INTRODUCTION

1.1 Aluminium(Al) is a metal. It has atomic number 13. It has silvery white appearance. In infaliminium. Aluminium is very agreesive in terms of the reactivity.

Aluminium has very low density. Aluminium and its alloys are very useful in aviation industry and in transportation. In non-ferrous metals, Aluminium is the most widely used one. The production of aluminium worldwide in aug 2019 is 5407 thousand metric tonnes.

1.2 Composites

A composite is a made by the integration of two or more materials which after combining becomes stronger than the single material. Composites have other name as Fibre Reinforced Polymer composites. Composites are created with a polymer matrix. It is reinforced with a fibre which is engineered by a man made or natural fibre. Fibres are prevented from external damage with the help of this matrix. And also fibres then provide the strength snd stiffness to the matrix in resisting cracks and fractures.

1.3 Friction stir welding

It is a type of solid state joining process in which two facing workpieces are joined together by a non consumable tool and the material of workpiece is not melted. In area between the workpiece and the rotating tool, heat is generated due to friction and this leads to a softened region.

In it the tool while traversing along the joint line and cojoining the two metal pieces mechanically, the hot and the softened metal is forged under pressure applied by the tool. This method is used mainly on wrought or extruded aluminium and for high weld strength structures. FSW has large applications in modern shipbuilding, aerospace and trains.

1.4 Tensile testing

A tensile test or tension test is one of the most basic kinds of mechanical testing. In a tensile test tensile force is applied to a material and response of the specimen for the stress is measured. Tensile tests determine the strength and elongation of the materials. It is conducted on electromechanical or universal testing instruments which are fully standardized.

Satheesh.M1*, M.Pugazhvadivu(2018) (1)

Al6061 reinforced by 0, 5 and 10 wt. % SiC & Al_2O_3 reinforcement particles were fabricated successfully by stir casting method. From the microstructure analysis, it is found that the hard ceramic particles were uniformly diffused in the metal matrix. Hardness of the composite increases with respect to the wt% of reinforcement particle increases. The addition of weight fraction of ceramic particles gives tremendous improvements in tensile strength. The superior tensile strength is obtained at 5 wt. % of SiC and after that tensile strength is reduced. Subsequently 5 wt% of Al_2O_3 composite increases the tensile strength then it is reduced. Ductility of the composite reduces marginally as the reinforced increases.

Prof. Sanketh S1, Prof. Anand Badiger(2017)

This literature survey brings into light the mechanical properties and various influencing factors such as volume fraction, microstructural properties, similarity and isotropic nature of the matrix and reinforcements as well as the shape, size and the quantity of individual.

K. Gajalakshmi*, N. Senthilkumar(2018)

This paper presents a review of influence of reinforcements in aluminium metal matrix composites through different fabrication techniques. The outcomes of the review are:

1) The wear property of the composite is enhanced with increase in reinforced ceramic particulate weight percentage.

2) At optimum stirring speed in stir casting technique (liquid metallurgy) the composite produced has lower porosity and matrix with homogeneously distributed reinforcement particles.

A Karthik1, M Shivapratap Singh Yadav2, Reddappa H N3, Ravikumar M4(2017)

1) The addition of Beryl to Al6061 resulted in enhancement of tensile and hardness property of the base matrix.

2) The wear resistance showed improvement as the wt(%) was increased. The COF values also showed decrease in value with increase in reinforcement percentage

3) While fabrication it was analysed that as the percentage of reinforcements were increased the composite became more brittle in nature.

2. OBJECTIVES

To study the mechanical properties of Al 6061 being processed under FSW method and then analysing the various properties of AL 6061 and to find out better and enhanced properties.

To evaluate the mechanical properties of the metal matrix composites on being compared with the matrix alloy.

3. ANALYZING OPTIMUM WELDING PARAMETERS

Composition of AA6061

Element	Si	Fe	Cu	Mn	Mg	Zn	Ci	Tr	Al
Percentage	0.4	0.35	0.15	0.15	1.2	0.08	0.1	0.1	Bal

FOR FWS AA6061 USING DESIGN OF EXPERIMENTS

This section includes a point by point investigation of the outcome of the FSW factors on the coveted reaction utilizing the plan of practical approach. It breaks down the connections of the different FSW parameters for contemplate and their weld property outcomes like UTS, % elongation and hardness on the making of numerical samples. RSM i.e response surface methodology is utilized for creating regressive conditions identifying with response and process factors. Consequences of the samples are exhibited in graphical form for the analysis. Approval of the numerical displaying of FSW tool probe geometry effects on the aluminium alloy weld is presented using analysis of variance (ANOVA) regression model.

5.2.4 Working Limitations of Parameters and Observations from Trial Experiments

Countless runs are done utilizing 2 thick weld plates of 5mm each of AA6061 wrought Al alloy to discover the possible limitations of parameters of FSW process. Distinctive mixes of process parameters are utilized for doing casual runs. It is done by changing anyone of the elements while acquiring whatever is left out of them at steady esteems. The running scope of every process parameter is settled on the base of these trials. The selected process parameters for welding of AA6061 plates are given in tables 5.1.

Table 5.1 FSW parameters of AA6061

SAMPLE NO	ROTATIONAL SPEED(RPM)	TRANSVERSE SPEED (MM/MIN)	TILT ANGLE
1	1200	79	0
2	1200	95	1
3	1200	124	2
4	1350	79	1
5	1350	95	2
6	1350	124	0
7	1500	79	2
8	1500	95	0
9	1500	124	1

FINAL EXPERIMENTATION

The FSW is started by bringing the FSW tool in a situation where the top part of the stick slides on the top surfaces of the abutted workpieces. FSW weldings of the aluminium alloy are made by combining the two (100 x 50 x 5)mm plates and making a weld joint of size 100 x 100 mm.

We fabricated 2 composite structures having; one having a Nomex Honeycomb Core of 5 mm thickness and another having a Nomex Honeycomb Core of 8 mm thickness. The face sheet and the epoxy in both the structures will remain same and consists of Carbon fibers (.6 mm Thick).

MICROSTRUCTURE

After the process the FSW joints are analyzed carefully under a microscope and various defects like penetration in welds, cracks in the weld and the zones affected by heat of welding are seen at different angles. The joints are also made to go through metallurgical testing in the concerned lab for getting optimum results and the results of microstructure are produced for each joint as mentioned

EXPERIMENTAL RESULTS

According to design matrix 9 experiments are performed. The responses for the experimental results are UTS, YS, %E and Hv. The data generated from the experimentation are given in tables and this data is used to develop the mathematical models by regression analysis to estimate the linear interactive effects on the weld joints produced by welding parameters. The mathematical models generated afterwards are useful for analyzing UTS, YS, %E and Hv of the FSW joints.

Mean Values for tensile test results

SAMPLE NO 1	MEAN UTS	MEAN % ELONGATION
1	85.50	5.43
2	77.00	14.58
3	50.66	14.36
4	90.33	9.38
5	69.00	10.95
6	104.0	13.03
7	60.66	14.36
8	75.00	12.66
9	81.00	10.33

Hardness Test

Each hill sample is put on the vicker's micro hardness machine and hardness study is seen on3 divides that is named as Parent metal, HAZ and nuggets one.

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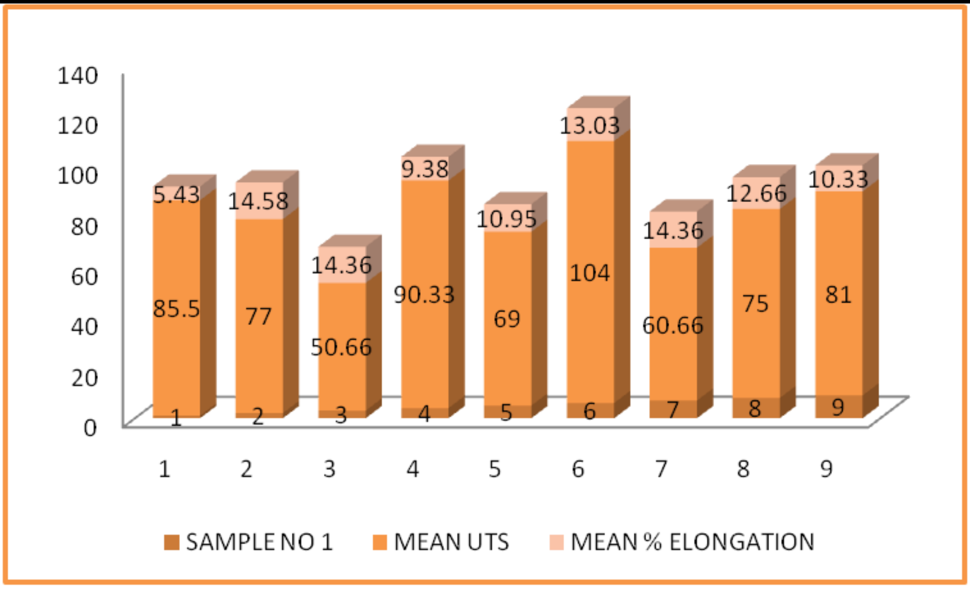

Regression Equation

HARDNESS HAZ = 35.6856 + 0.02507 RS_1200 + 0.01442 RS_1350 – 0.03949 RS_1500 - 0.07612 TS_79 + 0.00652 TS_95 + 0.06960 TS_124 – 0.00140 TA_0 – 0.01571 TA_1 + 0.01711 TA_2

The contribution % mentioned in the table 11 shows that the transverse feed 'T.S' is the most important factor for experiment analysed with 77.20% out of the total. Speed of rotation 'R.S' is at 2nd place paying 17.31% in total and the tilt angle 'T.A' is at third place of 3.91% of contribution.

Conclusions

1) FSW tool of tube shaped cavity is created effectively which is distinguished to be reasonable for the dissimilar welding of aluminium alloys.
2) The essential process parameters that influence the quality of the joints are distinguished. The working range of process parameters that give imperfection free joints are created for the comparable FS welding by trial experiments.
3) Similar FS joints are effectively created according to Central Composite Circumscribed design matrix utilizing square tool stick profile.
4) Regression modeling equations of the comparative FS welding.

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