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Friction Stir Spot Welding of Aluminium Alloy (AA6063)

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ABSTRACT

Friction stir spot welding (FSSW) is a simplest and quick process for joining aluminium alloys of (AA6063). The FSSW it is a different welding for other resistance spot welding. Aluminium sheets used in Aerospace applications, high speed trains, ship buildings and also automotive industries. By using aluminium alloys we can reduce the weight of the body.in friction stir spot welding (FSSW) process radial drilling machine was used as a main component for increase Tool speed and Feed. For this FSSW process on aluminium Alloy the spectial friction stir tool is prepared to spot weld. H13 and EN36 material drill bits used as friction stir spot welding tools.

By using aluminium alloys increasing the safety performance. FSSW is as solid state welding technique. I this FSSW process the heat generate between friction stir tool and aluminium alloys. By producing this heat we can make a accurate joint. In this joining processby the help of producing heat metal will be method and comes into solid state then the joint will be done.

KEYWORDS: *FRICTION WELDING, FRICTION STIR SPOT WELDING, RESISTANCE WELDING, WELDING, ALUMINIUM ALLOYS, SPOT WELDING, RADIAL DRILLING*

1. INTODUCTION

Friction stir spot welding (FSSW)is an idial component process for aluminium welding comparing to conventional resistance spot welding(RSW). FSSW is a derivative of friction stir welding (FSW) process. FSSW is a single spot joining process, in which a solig state joining is made between adjacent materials at ovelap configuration [1]. friction spot weld joining has four steps as shown in figure1.

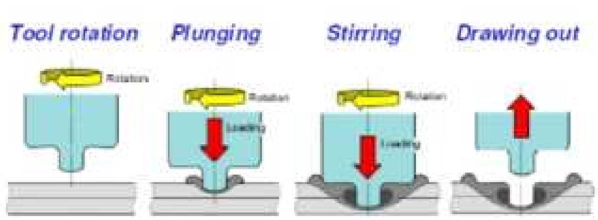


Fig.(1). FSSW Process

First the tool is positioned perpendicular to the work piece surface, and it starts to rotate. Next the tool pushed aginst the surface of the work piece. Friction heats the materials and the pin enters the softened mwtal. After the pin has plunged completely into the work piece, the tool continues to spin and apply pressure for a set lengthg of time. The materials around the pin are stirred together, and the tool is extracted from sheets [2]. the FSSW can be considered for many of the applications presently performed with traditional resistance spot welding, reverting, or mechanical clinching[3]Joint geometry of FSSW can be more efficient alternate process to electric resistance spot welding[5]. The FSSW has some district potential advantages on aluminium over other welding procesessuch as RSW,MIG spot as well as performing better thane mechanical joining techniques. The FSSW tends to have much lower operating costs due to improved energy efficiently and a vitual lack of consumable. Additionally the FSSW equipement requires significantly less surrounding in fracture. That is FSSW requires no water , no compressed air, nor complex electrical transforming equipem,ent[6].However,the litereture review indicate,there is a need to identify the effect of FSSW parameters on the weld performance[7,8].

2. EXPERIMENTAL PROCEDURE

Material Used: Aluminium alloy (AA6063)

Aluminium: Aluminium or Aluminum is a chemical element with symbol Al and atomic number 13. it is a silvery white, soft, non magmnetic and ductile metal in the boron group. By mass, aluminium makes up about 8% of the earth crust its is the third most abundant element after oxygen and silicon and the most abudant metal in the crust.

Aluminium Alloy (AA6063):

AA6063 is an aluminium alloy, with magnesium and silicon as the alloying element. The standard controlling its composition is maintained by the aluminium association. It has generally good mechganical properties and is heat treatable and weldable. It is similar to the British alluminium alloy HE9.Commerciallyavailable aluminium alloy plate (AA6063) with a thickness of 1.5mm were used to fabricate the joints. The chemical and mechanical composition of studied material is given in table 1.

Chemical and mechanical properties of AA6063 aluminium alloy

Physical properties	Mechanical properties	Thermal properties	Electrical properties
Density = 2.69g/cm	Youngs nodulus = 68.3Gpa	Melting temperature =615°c	Volume resistivity = 30-35 ohms
	Tensile srength = 145-186 MPa	Thermal conductivity = 201-218W/m*k	
	Elongation = 18-33%	Specific gravity = 900 J/kg*k	
	Poissons ratio = 0.3		

Table.1. Properties of AA6063

Samples for tensile were machined out in the dimension of 100x 25 x 1.5 mm.

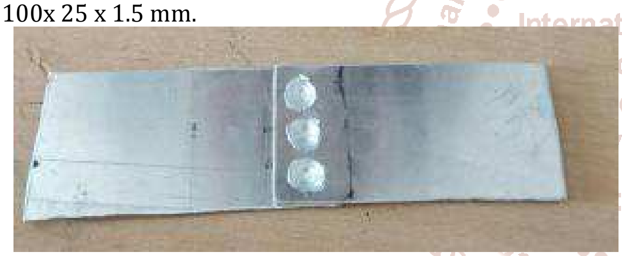


Fig (2).Aluminium plate.

TOOL USED

H13 Steel Rod:

H13 tool is a versatile chromium molubdenum hot work steel that is widely uesd in hot work and cold work tooling applications .in this applications H13 provides better wear resistance than common alloy steel such as4140.the diagram of the H13 rod as shown in below.

Fig.(3).H13 Mild Steel Rod

FEATURES OF H13 STEEL ROYND BAR
- Resistance to trust
- Perfect finish
- High tensile strength
- Enhanced durability.

CHEMIACL COMPOSITION	MECHNICAL PROPERTIES	HEAT TREATEMENT
Carbon =0.38%	Density=0.280I b	Forging=1900-1500A°F
Silicon =1.00%	Modulus of elasticity=7.75	Preheating= 1400-1500A°F
Manganese =0.35%	Machinability=7 0%	Hardening=18 25-1900A°F
Molybdenum =1.35%	Reduction of area=50%	Tempering=95 0-1150A°F
Vanadium =1.05%	Poissons ratio=0.27-0.30	

Table 2

The H13 steel was used as the FSSW tool material. The tool was manufactured with the dimensions shown in given below figure.the tool was hardened to 52hrc before the welding applications.pin height(h) was prepared as 2 mm the diameter of the tool pin was 4 mm.

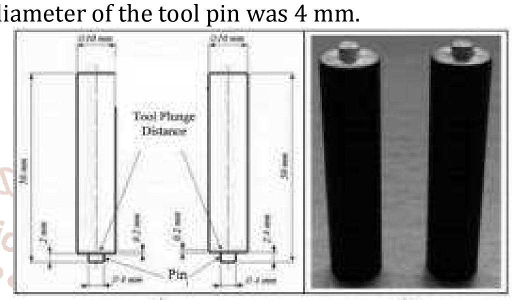


Fig.(4). Line d iagram of friction stir tool

Fig .(5).Friction stir tool

Prepared tool shank for better gripping of tool and high speed rotation purpose. The tool shank as shown below

Fig.(6).Tool shank.

TOOL HARDENING

Hardening:

hardening is a metallurgical metal working process used to increase the hardness of metal. The hardness of a metal is directly propotional to the uni axial yield stress at the location of the imposed strain.

Using Flame Hardening for better condition of Friction Stir Tool.

Flame Hardening:

flame hardening is similar to induction hadening, in that it is a surface hardening process. Heat is applied to the part being hardening, using oxy acetylene flame on the surface of the steel being hardened and heating the surface above the upper critical temperature before quenching the steel in a spray of water. The result of layer ranging from 0.050 to 0.250 deep.

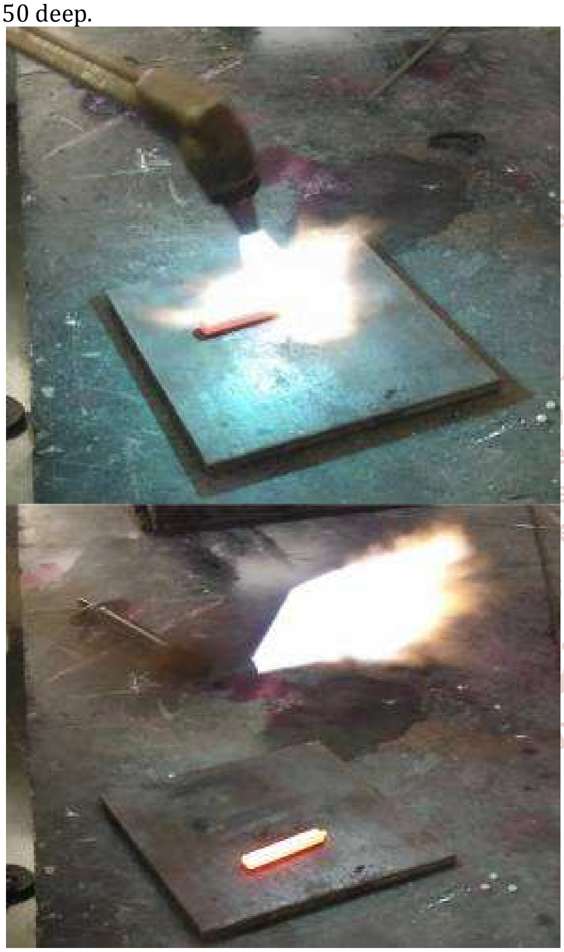


Fig.(7).Flame hardening for Friction Tool.

The Radial drilling machine used for Friction stir spot welding

Radial drilling machine:

the radial drilling machine is intended for drilling medium to large large and heavy work piece. The machine consists of a heavy, round, vertical column mounted on a large base. The column supports a radial arm which can be raised and lowered to accommodate work pieces of different height.

The FSSW welding was perfoemed on a radial drilling machine.prepared sample were joined with FSSW using different tool rotation speed, dwell time, and tool pin height. The process parameters are given as below table. Sample were joined for each of the parameter set . average of tensile test results of sample were used to evaluate the performance of joint. Prepared specimens were joined with FSSW process as shown in below.

Fig.(8).FSSW Process

Sample group	Pin height (mm)	Tool rotation (rpm)	Dwell time (s)	No.of welded samples
1	2 mm	850rpm	5s	1

Table.2

Tensile Shear Strenght Testing for welded plates

Tensile Test:

ensile testing is also known as tension is a fundamental material science test in which a sample is subjected to a controlled 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.[9,10].The test results must includes information on following point about test conditions.

- Type of sample(weld specimens) -strain rate (mm/min)
- -Temperature or any other environment in which test was conducted if any.
- -Topography, morphology, texture of the fracture surface indicating the mode of fracture and respective stress state.

Tensile shar test for 3 stir spot friction welding. Indentification Aluminium alloy (AA6063) plate 1.5 mm thick.

Sample No: 1

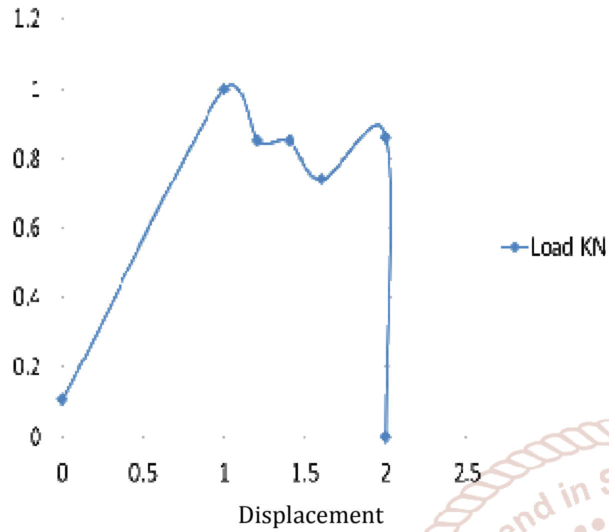
Input data	
Specimen type	Flat
Specimen width	29.9mm.
Specimen thickness	1.6mm
Cross sectional area	47.84mm^2
Original gauge length	50mm
Final gauge length	50.3mm

Table.3

Results	
Ultimate load	1.000KN
Ultimate tensile shear strength	20.903 N/mm^2
Elongation	0.600%
Yield load	0.920KN
Yield stress	19.231 N/mm^2

Table.4

Tensile shear test model graph



3. RESULT and DISCUSSION

Tool rotation for sample selescted as 850rpm, tool pin height 2 mm and dwell time 5 s and 10 s . Tensile shear strength results of test samples are given in above figure.The higher shear strength value exhibited the sample welded with 5 s than 10 s dwell time. The increasing in the dwell time from 5 s to 10 s reduced the tensile shear strength by 29%. the higher shear tensile strenght of the sample set can be arttributed to the higher pin tool height. Yuan et. AI [11] showed that in their studty the plunge depth profoundly influenced lap-shear seperation loads. The effect of tool pin height parameters on tensile shear strength is greater than dwelling time and too rotation. The results of the study indicates that should be optimum tool pin height which gives the highest tensile shear strength. Additional studies are needed to identify optimum parameters for the FSSW process.

4. CONCLUSION

From the results given above, the following conclusions can be drawn:

- The tensikle shear strength of FSSW significantly conclusions affected by tookl rotation, dwell time and tool pin height.
- The increse in tool rotation increses the tensile shear strength in a limited range of FSSW joints.
- The increase in dwell time reduces the tensile shear strength.
- The increase in the tool pin height increas the tensile shear strength.
- Effect of tool pin height parameter on the tensile shear strength is greater than dwelling time and tool rotation.
- There is an optimum tool pin heightwhich gives the highest tesndile shear strenght.

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