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EXPERIMENTAL ANALYSIS OF THE EFFECT OF DIFFRENT WELDING SPEED ON THE HARDNESS OF WELDED JOINT PLATE AA6082-AA6061 OBTAINED FROM FRICTION STIR WELDING

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ABSTRACT

Now a day the industrial application of the aluminium alloys has been limited due to the grater variation in the properties of the aluminium alloys during welding process. In this paper the FSW process of aluminium alloys has been done by varying welding speed and studied the effect of the speed on the hardness of the welded joint. In this study two different grade of aluminium grade AA-6082 and other is from grade AA6061 plate and cylindrical tool (Taper pin profile) used for Friction stir welding. The aim of the study is to find out the effect of Different welding speed on the hardness of the FSW joint of the plate grade AA-6082 and other is from grade AA6061.

Keywords: FSW, Aluminium grades thin sheets, Hardness test Rockwell (HRB), comparison of welding joint hardness.

INTRODUCTION

FSW is produced by rotating and plunging a specially-designed cylindrical, shouldered tool with a small diameter pin into the joint line between two butted plates. Frictional heat causes the metal to soften and allows the tool to traverse along the joint line. In this research, the process of butt joints with the effect of the varing welding speed on the hardness of the welded joint is investigated. The two plates are clamped on a rigid back plate. The fixturing prevents the plates from spreading apart or lifting during welding. The welding tool, consisting of a shoulder and pin, then rotated to a prescribed speed. The tool is slowly plunged into the work piece material at the butt line, until the shoulder of the tool forcibly contacts the upper surface of the material and the pin is a short distance from the back plate. A downward force is applied to maintain the contact and a short dwell time is observed to allow for the development of the thermal fields for softening the material along the joint line. At this point, a lateral force is applied in the direction of welding (travel direction) and the tool is forcibly traversed along the butt line until it reaches the end of the weld. Alternately, the plates could be moved while the rotating tool remains stationary. The FSW process of butt joints is shown in Figure.

Figure 1 Experimental set-up of Friction Stir Welding

PARTS OF EXPERIMENTAL SET-UP

Clamping Fixture

The friction stir welds have been carried out by using a properly designed clamping fixture that allows the user to fix the two sheets (150mm × 150mm) with the plate of 3mm thickness to be butt welded on a vertical milling machine. Figure shows the vertical milling machine and clamp used for experimental work.

Figure 2 Setup and clamping of FSW plates

Milling Machine

Table-1 Specification of milling machine:

Make	BFW	
Model	HF1	
Table Size	1175mm x 230mm	
Movement	Longitudinal	590
	Transverse	270
Speeds	45-2000rpm	
No. of Feeds	18	
Feed Range	16-800 mm/min	

Experimental Setup describing clamping and welding of FSW plates in this investigation the base materials, AA6082 or AA6061, which is a hardened aluminum alloys widely used in aerospace applications due to its high strength was used. The mechanical and chemical properties of AA6082 or AA6061 are shown in Table 2 and Table 3 respectively.

MATERIAL PROPERTIES

The material used in the experiment is AA6082 or AA6061 have good properties in the parent condition are shown below.

Table-2 Mechanical properties of AA6082-AA6061

Material	Hardness (HRB)	Ultimate Strength (MPa)	Yield Stress (MPa)	% Elongation
AA6082	47.9	185	60	14
AA6061	50.8	190	65	16

Table-3 Chemical compositions (wt. %) of the base metal

Base Material	Cu	Mg	Si	Fe	Mn	Zn	Ti	Cr
6082	0.1	0.4	0.6	0.6	0.4	0.1	0.2	0.25
6061	0.15	0.7	0.4	0.7	0.8	0.2	0.2	0.15

WELDING TOOL

Figure shows the image of tool pin profiles used in this research work in order to fabricate the joint which is the taper shape pin is shown in figure. The big diameter of the pin and small diameter of the Taper pin 5.54mm 4.30mm.The material of tool is AISI H13.

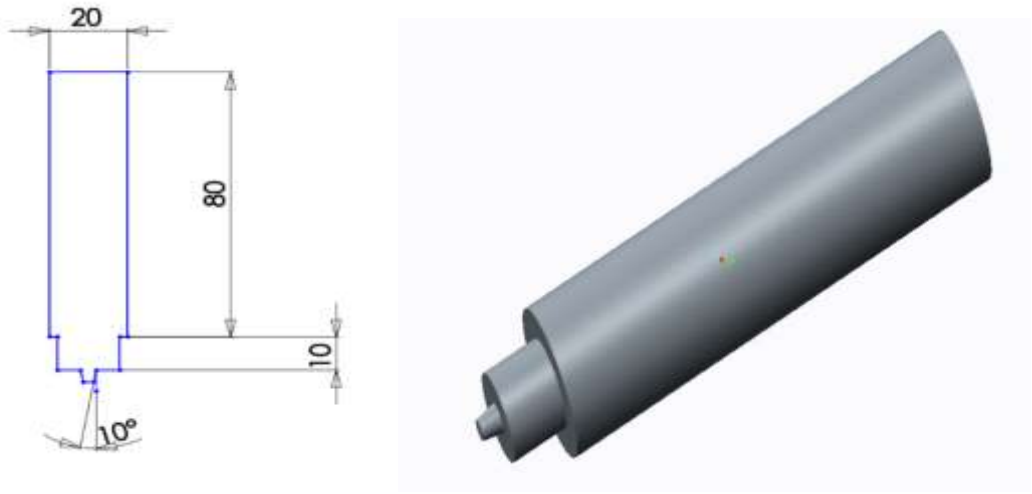

Figure 3 Tool Profile

Taper shape tool pin profiles used in this study, heat treatment of tool as per ASTM A-681 for good mechanical properties under the practical performance.

Table-4 Heat treatment

Temperature	1010^0C
Time	30 min
Cooling	Air cooled
Hardness	50 HRC

Table-5 Properties of AISI H13

Density Kg/M^3	Thermal conductivity W/m-k	Thermal Expansion 60^{-6}/ºC	HRB
7.76	28.6	10.4	95

WELDING PARAMETERS

The most important welding parameter is the rotation speed, the transverse speed and plunge depth. This Study is based on varying Rotational speed of tool. Rotation speed determines the heat input and temperature as well as the shear experienced by the FSW welds. The initial joint configuration was obtained by securing the plates in position using mechanical clamps. The direction of welding was normal to the rolling direction. Single pass welding procedure is used to fabricate the joints. The welding parameters used to fabricate the joints are presented in Table.

Table-6 Welding parameters

Rotating speeds (rpm)	1400
Welding speeds (mm/min)	80,100,125
Pin length (mm)	3.6
Tool shoulder diameter (mm)	12

SPECIMEN PREPARATION FOR TESTING

Dimensions of specimen are 150mm x 300mm Which is used in the test for finding Hardness. Rockwell tests were performed to determine the hardness of specimen. Three specimens are tested at each condition and average of the results of three specimens is measured as a final result.

Figure-4 Specimens for Test

RESULT AND DISCUSSION

The obtained results from the tests are shown in table 7. To understand the effect of FSW process parameters such as welding speed on Hardness of friction stir welded AA6082-AA6061 aluminium alloys joints. Result shows the effect of the welded products for taper pin profile Tool with Different welding speed.

Table- 7 Results at different Welding Speed mm/min

S.No	HARDNESS IN HRB	AT SPEED OF mm/min	TEST METHOD
1	59	80	IS:1586-2012
2	61	100	IS:1586-2012
3	57	125	IS:1586-2012

CONCLUSION

The above result shown in table is obtained from the Friction stir welding of the plates made from aluminium alloys grade (AA6082-AA6061). In this paper, AA6082-AA6061 alloys were welded for checking the hardness of welded joint by test method Rockwell (IS: 1586-2012) by using FSW process. Taper shape pin profile of tool is used for joining plates and study the hardness of joints at different welding speed is investigated in this experimental analysis. In this test, the following conclusions are derived from the result obtained from the experimental analysis of aluminium alloys are as follows:

- The friction stir welded plates of AA6082-AA6061 by using the taper pin profile at a welding speed of 100 mm/min reaches the hardness of 61HRB. It is found that increasing the welding speed after some certain limit the hardness of the joint goes down like at speed of 100mm/min it is 61HRB and at speed of 125 mm/min it goes down 57HRB.
- The results indicate that welding speed also has a significant effect on the hardness of the welded joint and on the mechanical properties of the specimen material.The founded hardness of joint is grater then the hardness of parent material.

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