Middle-East Journal of Scientific Research 15 (10): 1415-1419, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.15.10.11586

The Preheating Influence on Welded Joint Mechanical Properties Prepared by Friction Stir Welding Aluminum Alloy H20-H20

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Abstract: This paper presenting the influence of preheating in mechanical properties like Vickers Hardness and Tensile Strength of friction stir welded (FSW) joint of Aluminum Alloy H20 and H20 conventional joint in three different preheating temperature 150 c -200c -250 c.the previous investigation on this aluminum alloy shows that the surface condition of welds was not satisfactory specially in the back of the welded joint. as we know heat generated by contact of tool and work piece is the weld cause thus the preheating process should improve the mechanical properties like Tensile and hardness properties.

Key words: Friction stir welding (FSW) · Aluminum alloy H20 Vickers hardness test · Tensile test

INTRODUCTION

Friction stir welding developed in united kingdom in 1990 now it is widely used by different application in advanced manufacturing systems all over the world.it is based on different type of tools penetrate in to the variety of joint configuration and rotating both in traveling and rotating speed thus the heat generated cause welding between two part of metal. It was initially used by aluminum only but now it is used by variety type of metals [1]. The preheating is one of the most important factors used to improve the welded joint characteristics of all welding processes in some cases heat treatment also use to improve welded joint mechanical properties [2] The welding process of the aluminum is increasingly used in the different industries. The use of this welding process requires a good understanding of the microstructure generated by the rapid temperature rise in the HAZ (heat affected zone).in some applications before using the anytraditional welding process, the aluminum were heat treated at different temperatures. after the welding, it has been found that the strength of the Material used in the HAZ (heat affected zone) was reduced due to different phenomenal that occurred during the welding process. Also, the correlations between the microstructure evolution and mechanical properties is always important factors in welding joints qualification [3]. Frictionstir welding base on the principal of welding cause by heat generated by friction the work pieces back side always have lower welding characteristic and quality. Basic thermal model includes diffusive heat transfer in the work pieces and that backing plate, convective heat transfer in the work pieces caused by the material flow, heat generation at the tool, heat loss to the ambient air and heat transfer between the work pieces and the backing plate [4]. Therefore the preheating process may improve the weld joint mechanical properties.

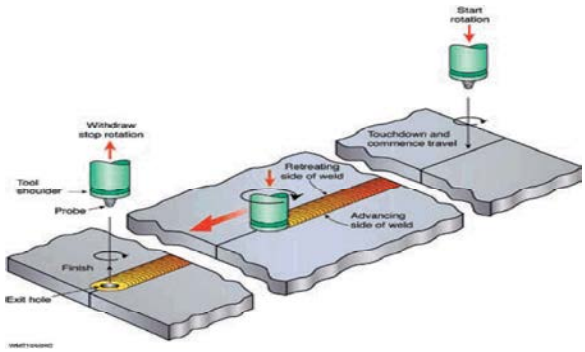

Fig. 1: Schematic of Typical FSW.[5]

Experimental Details: We decided to use CNC milling machine BMV 45 to welding the work piece of aluminum in this project the work shop was located in Balanegar Hyderabad India. We used rotational speed 1000RPM feed 20 mm and travel speed 20mm/m with triangular tool in this investigation (Tool material wasHigh speed steel (Wc-Co)).

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Fig. 2: CNC MILLING MACHINE BMV 45

Table 1: Spacification of Cnc Millin Machine Bmv 45

No	Part name	Specification
1	3-axis machine center	Spinner
2	Model	BFW45
3	Spindle driver	Servo motor
4	Spindle range	10-6000 RPM
5	Tool holder	ISO 40
6	Cutting fluid	NR
7	Tool	HSS
8	Work piece	Aluminum Alloy H20
9	Movement	610*450
10	Bed size	800*500

CNC Program: We was using this CNC program for mentioned CNC milling machine and work piece dimensions and materials [6].

- 00010(DIA 16.0EM 45 DEGEREE TIP CUTTER)
- N01 (FRICTION STIR WELDING)
- N02 (DATE 11-01-2010 TIME 20:15:08)
- N03 G0G17G40G49G53G80G90
- N04 G5.1Q1R10
- N05 G91G28Z0
- N06 M03S950
- N07 G90G54X0.0Y0.0
- N08 G43H6Z50
- N09 G1Z2F800
- N10 G1Z-3.8F16
- N11 X170
- N12 G0Z50.0M09
- N13 M05
- N14 G91G28Z0
- N15 G5.1Q0

Aluminum Alloy H20 and H20: Aluminum Alloy H20 has good corrosion Resistance,good machinability with control in grain structure and also good strength properties.Beside this itcan used in different type of manufacturing systems especially in platform manufacturing.therefor Aluminum Alloy H20 is suitable for FSW process. [7] different type of welding techniques may use in aluminum alloys welding [8] but the flexibility, eases and accuracy of friction stir welding cause its wide application in different industries.the work piece geometry have a direct effect to the heat transfer in any welding process and the weld quality will affected base on this important concept. [9] in friction stir welding also the weld joints quality will affected by weld geometry we are using the following geometry because they are suitable with our CNC milling machine,tool and our work pieces materials.

Fig. 3: Aluminum alloy H20 work piece

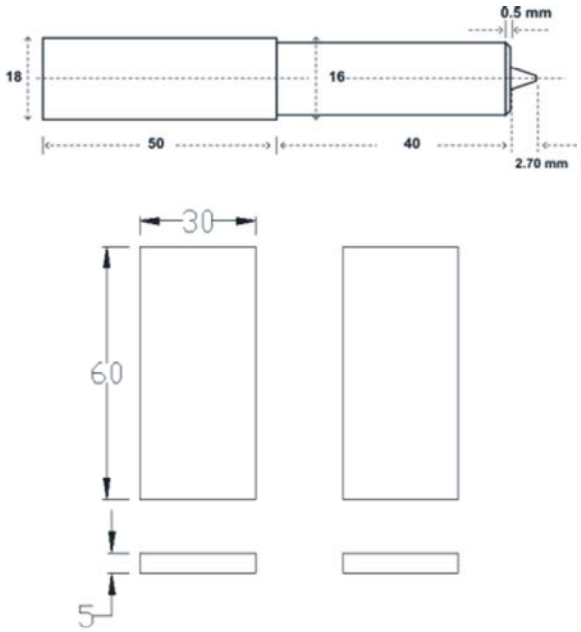

Fig. 4: Tool and work piece Dimension (conventional joint) [9]

Weld Testing Procedures

Vickers Hardness Test: Vickers Hardness Test based on the principal that the testing tool apply to the work piece welded joint. the geometry of changing in the work

The workpiece samples photo as following:

Fig. 5: Workpiece samples

Fig. 6: Workpiece samples

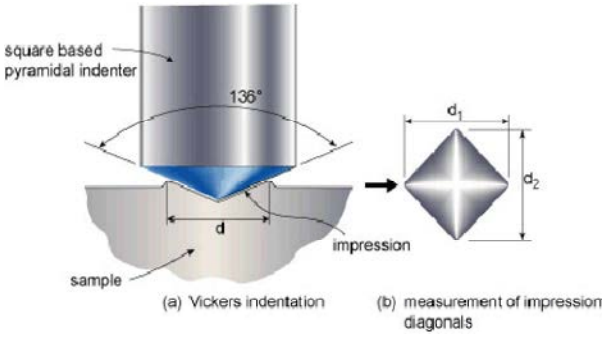

Fig. 7: Vickers Hardness Test Terminology [10]

piece demonstrate on the figure 7 with d and h and the Vickers number will calculated by following formula with using a microscopic method:

$$DPH = \frac{2P\sin(\theta/2)}{L^2} = \frac{1.854P}{L^2} \quad (1)$$

Where:
P-Applied load by Pyramid shape diamond (kg).
L or D-area of indentation(mm).
θ-angle between opposite faces of diamond = 136°

Tensile Test Procedure: This is the time to perform Tensile test this test performed by universal testing machine (UTM)if S equal to Cross-sectional area and F is the maximum force then :
tensile strength =R=F/S(MPA) (2)

RESULT AND DISCUSSION

We welded the joint as mentioned before in four condition first without preheating the second case was with 150 C preheating third is with 200 C preheating finally with 250 C preheating. The quality of welded surface seems to improve by increasing the preheating temperature.

Fig. 8: Friction stir welded aluminum alloy H20 down without preheating and upwith 250 C preheating.

Table 2: Friction Stir Welded Joint Aluminum Alloy Vickers Hardness Number(vhn)

Friction stir welded joint without preheating	S.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Distance from the weld start position	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Vickers Hardness Number (VHN)	57.9	62.2	56.8	55.3	51.7	50.6	49.4	44.8	51.1	49.8	53.5	51.5	51	53.5	57.5
Friction stir welded	S.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
joint with150 C	Distance from the weld start position	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
preheating	Vickers Hardness Number (VHN)	74.3	87.3	74.3	76.2	79.4	69.8	73.4	84.1	78.3	85.5	73.2	76.2	76.4	84.3	82.2
Friction stir welded	S.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
joint with200 C	Distance from the weld start position	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
preheating	Vickers Hardness Number (VHN)	84.3	69.6	93.3	87.2	102.3	76.4	86.3	84.6	96.2	84.2	87.2	83.6	69.3	96.3	97.3
Friction stir welded	S.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
joint with250 C	Distance from the weld start position	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
preheating	Vickers Hardness Number (VHN)	86.6	84.2	97.4	78.9	86.2	92.2	86.4	67.4	91.7	77.3	87.6	101.7	92.1	84.3	87.7

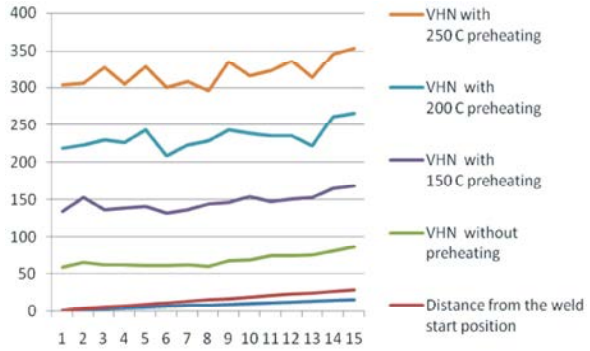

Fig. 9: Vickers Hardness Number Friction stir welded joint aluminum alloy H20-H20.

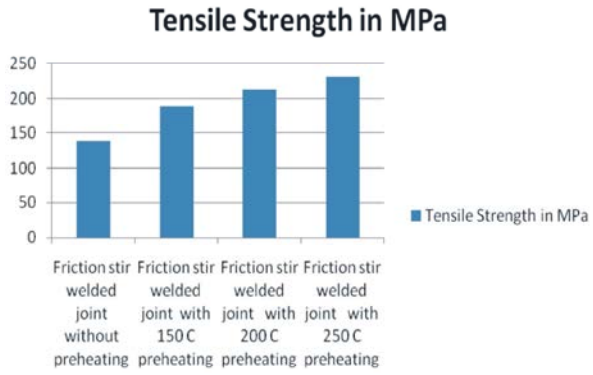

Fig. 10: Tesile strength in MPA

The Vickers hardness test results as the following table as we can see for each work piece Vickers hardness number varied by changing by the distance from the center of the weld without any meaningful relationship.but the hardness characteristics generally improve thorough increasing the preheating temperature. And it is just because grain refinement in the stir zone [11].

Also The results of the tensile testing are as following:

Table 3: Friction stir welded joint aluminum alloy H20-H20Tensile Strength in MPa.

Type of Joint	Tensile Strength in MPa
Friction stir welded joint without preheating	138
Friction stir welded joint with 150 C preheating	189
Friction stir welded joint with 200 C preheating	212
Friction stir welded joint with 250 C preheating	231

Also tensile strength is increasing by raising the preheating temperature.

CONCLUSION

Work pieces made by aluminum alloy H20-H20 can be welded by Friction stir welding with good surface condition. Vickers Hardness Number (VHN) change by increasing the displacement from the center of the weld (weld position) without any meaningful relationship between numbers (the numbers are fluctuating). Preheating generally increase Vickers Hardness Number and therefore hardness qualification of the welding process beside this preheating increase Tesile strength of the weld joints quite considerably.therefore preheating recommanded both when the friction stir welded joint under horizental or vertical high loads.

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