International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

An Experimental Investigation on Mechanical Properties of Friction Stir Welding of Al(6061-T6)and Brass(IS319) by using EN19 Circular and Taper Profile Tool

Ch.Ranga Rao[1], B Srinivasulu[2], K Bhargav[3],M Ravi Kumar[4],E Mounish Varma[5],G Sai Siddartha[6]

[1]*Associate Professor, St. Martin's Engineering College, Dhoolapally,Secunderabad,*
[2]*Research Scholar, Sri Satya Sai Institute of Technology and Medical Sciences, Sehore, Bhopal,M,P.*
[3,4,5,6]*Final Year B.Tech, Mechanical Engineering, St.Martin's Engineering Collge, Secunderabad, Telangana, India*

Abstract - *Friction stir welding(FSW) is a solid state joining course originally urban and patented l by TWI(The Welding Institute),UK. This procedure is energy efficient, no distortion of the welds, no require of filler material and no gas fumes. The materials are joined due to growth of heat as of friction between tool and work piece. Till date the course is not so far commercialized. In the in attendance document we are significance the experiments conduct on a conventional milling machine by using EN19 Tool with circular and Taper profile and work material is Aluminum(6061-T6) and Brass(IS319) 100x100x2 mm plate. Mechanical properties viz Tensile strength, Yield Strength, Hardness are evaluated on the welded joints. EN19 with taper thread profile has given Tensile strength of 108 N/mm2,Yield strength 76. N/mm2 and Vickers hardness 51.73 HV*

***Key Words*: Friction Stir welding, Aluminum (6061-T6) , Brass(IS319). EN19 tool ,Circular Profile, Taper pin profile.**

1. INTRODUCTION

Friction Stir Welding is a solid state joining process and substance are connected without attainment the melting point. Using this method elevated eminence weld are made 2xxx series and 7xxx series alloys which are impossible weld by other welding. This procedure is broadly use in innovative history for a variety of industrial application in aerospace, automotive , civil structures and ship building industry. This process do not need filler rod and shield gases as well as the course do not have splash, spatter. The essential quality of the FSW procedure is illustrated in the Fig1 In this course a rotating tool by a analytical pin penetrate in to sheet till the tool shoulder contacts the top of the sheet. The downward tool force and the tool rotational speed produce a frictional heat amid the tool and work piece. Tool plays an significant position for friction stir welding process. M.MILICIC et el(2015) explained in his paper FSW welding is a thermo mechanical process and it is characterized by conduction heat transfer due to friction between tool and work piece and material flow in the zone of heated material. The shape of the tool plays an important role. The power of the tool can be resolute by conducting the various experiments. In this document we be explaining the Friction stir welding of dissimilar metals Aluminum (6061-T6) and Brass(IS319) by using EN19 circular and taper profile and the welded joints are evaluated by Tensile Strength, Yield strength and Vickers Hardness.

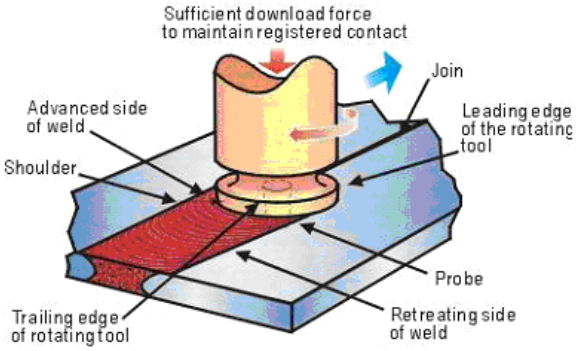


Fig 1. Basic Features of Friction Stir Welding

2. Literature Review:

FSW Patented by The Welding Institute, UK in 1991. Several experiment has been conducted on Copper and Aluminum alloys, Steel, Titanium etc A simplified equation in a Friction Stir Welding is expressed a equation as (3)

$$Q=\mu\Omega FK$$

Where Q=Heat is produced due to friction(μ) between tool and work piece

Ω = Tool rotation speed

F=Down Force

K=Tool Geometry Constant

The following table adopted from Esab Technical guide showing the relation between Tool and work piece Table 1 and Table 2

Table 1: Main Process Parameters in Friction Stir Welding(3)

Parameter	Effect
Rotation Speed	Frictional heat, "Stirring",Oxide layer breaking and mixing of material
Tilting angle	The appearance of the weld, thinning
Welding speed	Appearance, Heat control
Down force	Frictional heat, maintaining contact conditions

Table 2: Welding Temperature range of various alloys(3)

Alloy Group	Temperature Range in Deg C
Aluminum alloys	450-550
Magnesium alloys	250-350
Copper alloys	600-900
Carbon and Low alloy steels	650-800
Titanium alloys	700-950

Rai et al(2011) has explained various types of tools used in Friction stir welding process in his review paper. The most commonly used tool is Tool steel for aluminum and magnesium alloys. These tools can also be used in Joining dissimilar metals. Two important factors in Friction stir welding are Weld quality and Tool Wear. Proper selection of the tool influence the weld quality. The flow of material will depend on the Tool geometry(4). The other important factors for affecting the wed joint are shoulder dia, tilt angle, pin geometry. In this experiment we have selected EN 19 as a Tool material due to its inherent advantages for welding Aluminum(6060-T6) and Brass(IS:319)

3.0 Experimental setup

In this procedure the Brass plate of 2 mm thickness, 100mmx100 mm with grades IS:319 is selected.EN19 Tool was chosen with a circular and taper with helical grooves are chosen with a dimensions as exposed in the Table 9. The mechanical properties of the EN19 and Brass IS:319 and Aluminum(6061-T6) are depict in the Table3, Table 4. Table 5, Table 6, Table 7 and Table 8. The research was conducted on a conventional Milling machine and the experimental set up as shown in the Fig.2

Table 3: Chemical composition of EN 19 Alloy Steel

C	Mn	Cr	Mo	Si	S	P
0,35-0.45	0.5-0.8	0.9-1.5	0.2-0.4	0.1-0.35	0.05	0.035

Table 4: Mechanical Properties of EN19 Alloy Steel Source : Smiths Metal Centres, Data Sheet 2017

Tensile N/mm2	Yield N/mm2	Elongation %	IZOD KCV J	Hardness Brinell
850-1000	680	13	50	248-382

Table 5: Chemical composition of Brass as per IS:319

Cu	Pb	Fe	Zn
62-63	0.5 to 1.5	0.20	Balance

Table 6: Mechanical Properties of Brass as per IS:319

Tensile Mpa	Yield Mpa	Elongation %	Hardness HB
285	150	10	90-160

Table 7: The chemical composition of AL(6061-T6) Soururce: Adinath Extrusions, Jamnagar, Gujarat,India

Al	Cr	Cu	Fe max
95.8 -98.6	0.04-0.35	0.15-0.14	0.7

Table 8 :The mechanical properties of Aluminum(6061-T6)

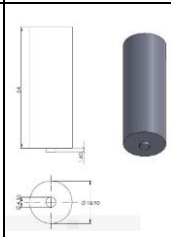
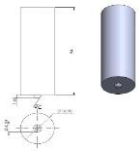
Tensile Ultimate MPa	Yield strength Mpa	Hardness Vickers	Elongation
310	276	107	12%
Source: Glemco, USA Data Sheet			

Fig 2. Experimental set up

3.1 Process Variables

A), Tool Design: The Design of the tool is an important factor. It determines the quality of weld and its maximum welding speed, The tool materials should be very strong, tough, hard and wear resistance at the welding temperature. EN 19 material was selected as tool materials. It is elevated value alloy steel with tensile strength, good ductility and shock resistance. It is extensively used in automotive gears and parts, shafts, towing pins, load bearing tie rods, Oil and Gas Industry appliance.

Table 9: Process Variables

Parameters	1	2
Tool Profile	Circular	Taper
Rotational Speed(RPM)	900	900
Feed(mm/min)	20	20
Depth of cut(mm)	1.6	1.6
Inclination angle	0.5 deg	0.5 deg
Tool		

B) Rotational Speed of the Tool: The Rotational rate of the tool is also recognized as machine spindle RPM affect the eminence of the welded Joint. The raise in rotational speed, the heat generated by friction also increases which directly affect the temperature at welding position. For this experiment Rotational speed 900 RPM is selected.

C) Welding Feed Speed : The welding feed speed is also recognized as tool advance speed is also affect the welding joint eminence. With decree in tool rotational speed the time for which the tool in contact with work increases, so that the heat generated due to friction is also increases which directly affect the temperature at the welding place. The feed is selected 20 mm/min

D) Depth of Cut(Axial Force): The depth of cut is also termed as axial force necessary to weld the joint. Depending on the thickness of the material this force is diverse . There is a restraint of this energy base on the machine specifications and thickness of the materials selected. In our case the depth of cut is fixed 1.6 mm.

Fig 3 En19 Circler Pin Weld metal

Fig 4 EN19 Taper Pin

4. Results and Discussions:

The final welded joints are depict in the fig 3 EN19 tool by circular profile, Fig 4 EN 19 Tool by taper profile. The welded joints are tested the mechanical properties viz Tensile Strength, Hardness are evaluated.

4.1 Tensile Strength

This test is worn to determine the strength of a welded joint. This test is conducted on a Universal Testing machine.

The final results of the Tensile Strength and Yield strength are shown in the Table 8

Table 8

Sl.No	Tool Profile	Tensile Strength N/mm2	Yield Strength N/mm2
1.	EN 19 Circular	74.06	49.10
2	EN 19 Taper	108.5	76.05

4.2 Hardness Testing:

The Hardness is measured by using Vickers Hardness testing machine. The final results of the welded pieces are shown in the Table 9

3 Table 9

Sl.No	Tool Profile	Vickers Hardness HV
1.	EN 19 Circular	84.63
2	EN 19 Taper	51.73

5. CONCLUSIONS:

An experiment has been conducted on a Milling machine to know the mechanical properties of Friction stir welding of Dissimilar materials Aluminum(6061-T6) and Brass(IS:319) with 100x100x2mm thick plate by using EN19 Tool Circular and Taper Profiles. The welded joints are tested, the mechanical properties of Tensile Strength, Yield Strength, Vickers Hardness are verified . The welded joint with Taper Profile has given better results among all the other tested samples. The values are Tensile Strength 108.5N/mm2, Yield Strength 76.05 N/mm2 Vickers Hardness 51.73 HV and for Circular Tool The Tensile Strength is 74.06 N/mm2 and Yield Strength 49.10 N/mm2 and Vickers Hardness 84.63 HV

REFERENCES

1. Sarang Shat, Sabri Tosunogle ,"Friction Stir Welding: Current State of the art and future prospects",WSMI2012,Florida,July 17-20,2012

2. M.MILICIC et al, Friction Stir Welding(FSW) Process of Copper alloys, ISSN 0543-5846,20/7/2015

3. Introduction to FSW Technical Hand Book, ESAB company manual

4. R Rai et al, Review: Friction Stir Welding Tools, Science and Technology of Welding and Joining, Vol 16, No4,325-342

5. Ch,Ranga Rao, B Srinivasulu, "An experimental investigation on Mechanical properties of friction stir welding of copper by using EN19 and EN31 circular and taper thread profile tool, IJETSR, ISSN-2394-3386, Vol4, Issue 10, October 2017

6. V.C.Sinha et al, "Microstructure and mechanical properties of similar and dissimilar joints of aluminum alloy and pure copper by friction stir welding, Science Direct Open access journal, Perspectives in Science(2016) 543-546