International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 06 June 2024
Page No: 1578- 1581
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0216

Effect of Friction Welding Conditions on Mechanical Properties of AA6082-AA2024 Joint

Deepak Kumar Mohapatra[1], Pragyan Paramita Mohanty [2]
[1,2]Department of Mechanical Engineering, Veer Surendra Sai University of Technology Burla, Odisha, India.
Emails: *deepakmechachamp@gmail.com[1], pragyanmohanty.design@gmail.com[2]*

Abstract
The work highlights weld quality as a gauge of weld performance and examines the impact of rotational speed on friction stir-welded (FSWED) AA2024 and AA6082 alloys using square tool. Utilizing Square stir tool of shoulder and pin diameters of 20 mm and 7 mm, respectively, both alloys (6 mm thick) were joint. Using varying rotational speeds—1000, 1400, and 2000 rpm—specimens were welded at a specified tool traverse speed of 25 mm/min. Both Flexural Strength and tensile strength were strongly impacted by variations in parameters. Maximum Tensile and Flexural strengths obtained at 1000 RPM and 20mm.min i.e. 143.43 MPa and 282.17 MPa respectively.
Keywords: *Friction Stir Welding; Rotational Speed; Tensile Strength; Flexural Strength.*

1. Introduction

Compared to other joining techniques, friction stir welding (FSW) is thought to be a unique, dependable joining procedure that reduces distortion and flaws. FSW produces fewer flaws and better mechanical qualities than the fusion welding procedure. High-quality junctions between different and similar metals, as well as nonmetals, can be produced with FSW. It may link different metal and polymer even when its physiochemical and mechanical properties differ greatly [1]. The procedure removes major faults, but because the FSW settings were not chosen appropriately, the quality of the joints declined [2],[3]. Tool rotational speed, feed, and tool profile were identified by Asmara et al. [4] as the key factors affecting the mechanical characteristics of the weld junction. The most crucial factor in a friction stir welded joint is its tensile strength. Researchers have examined this property using a variety of mathematical and experimental techniques, observing how process parameters affect tensile strength and connecting mechanical characteristics to the weld's microstructure [5]. Numerous studies have been conducted utilizing the FSW parameter optimization for a range of characteristics, including corrosion, microhardness, and tensile strength [6]. The effect of process parameters on the mechanical properties of friction stir welded (FSWED) joints is currently the focus of research on friction stir welding of aluminium alloy [7-10]. Nonetheless, a few studies have been done with flexural strength as a performance factor. Determining the ductility of the welded junction also requires consideration of its bending strength. Flexural strength is reduced as a result of the welded joint being more brittle.

1.1. Experimental Procedure

The base materials for the experiment were aluminium 6082 and aluminium 2024 alloys. The sample was correctly aligned and clamped in a vertical milling modified centre (Figure 1). Tables 1 provide the chemical composition of the base metal plates (AA 6082 alloy and AA 2024 alloy) used in the welding process. The 6 mm thick plate was wire-cut using an electrical discharge machine (EDM) to dimensions of 100 mm and 75 mm. The plate's edge was cleaned and smoothed with a file to create an oxide-free coating. A H13 steel non-consumable cylindrical tool measuring

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 06 June 2024
Page No: 1578- 1581
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0216

18 mm in the shoulder, 6 mm in the pin, and 5.5 mm and 3.8 mm in length was in order to accomplish the welding operation (Figure 2). The FSW process performed on VF- Milling machine available at CTTC lab Bhubaneswar. Range of parameters considered for the joining of Al6082 and Al 2024 alloy plates with square threaded H13 tool. In order to soften the base material, the rotating square tool was subjected to plunge for 20 seconds into the plates. After the friction welding process, the plate is shown in Figure 3.

Table 1 Chemical Composition

Element (%)	Si	Fe	Cu	Mn	Mg	Zn	Ti
AA 6082	1.3	0.5	0.1	1.2	1.0	0.2	0.1
AA2024	0.5	0.5	4.9	0.9	1.8	0.25	0.15

Figure 1 Friction Stir Welding

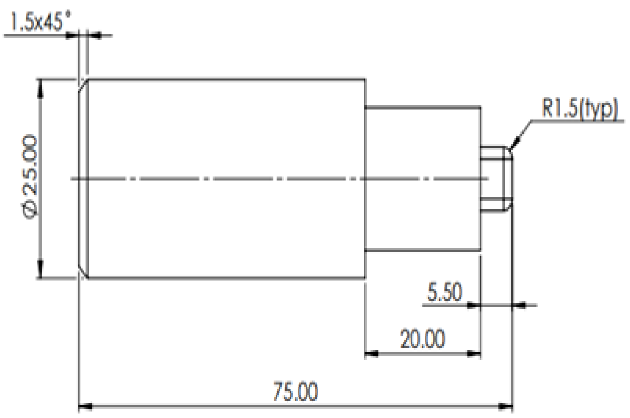

Figure 2 Tool (A) Square

Figure 3 After Friction Stir Welding Plate

2. Result and Discussion

Two weld quality parameters, namely ultimate tensile strength (UTS), bending Strength were measured. Both Tensile and bending specimens were prepared as per ASTME 8 standard which is of dog bone shaped tensile specimen was taken as100mm×10mm×6mm and the dimension of flexural specimen was taken as100mm×10mm×6mm. and the tests were performed on a universal tensile testing machine of 50 kN capacity (ASTRON 3382) with 1 mm/min cross head speed. Fracture location in all test samples is found to be nearly HAZ zone as shown in Fig.6 which is close to centre of weld. Maximum tensile strength obtained is 143.43 MPa and Bending strength obtained as 282.17 MPa when AA2024 held on advancing and AA6082 on retreating side. Tensile strength initially increases with rotational speed and then decreases for a given constant traverse speed, 20 mm/min in Figure [4-6] & Table [2-3].

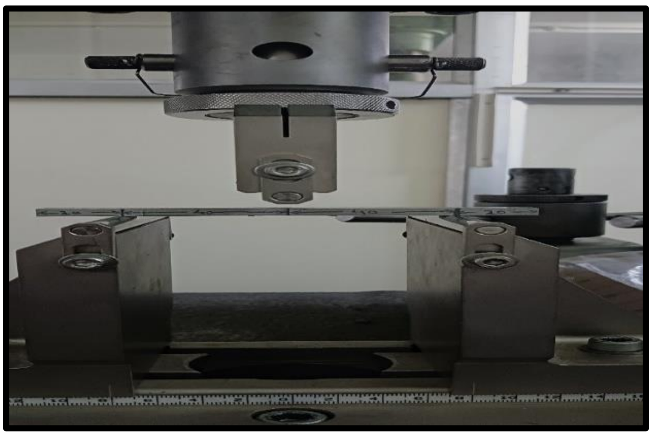

Figure 4 Universal Testing Machine

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 06 June 2024
Page No: 1578- 1581
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0216

Figure 5 Tensile Specimen After Failure

Figure 6 Specimen After Bending

Table 2 Mechanical Strength of AA6082-AA2014 FSW Welded Joints Related to Trial Conditions with Square Tool Pin Profile

Trial No	Trial condition			Bending Strength (Flexural Strength)
	Rotational Speed (rpm)	Welding Speed (mm/min)	Tool Offset (mm)	(MPa)
1	700	20	0	182.15
2	1000	20	1	282.17
3	1400	20	-1	162.5

Table 3 Mechanical strength of AA6082-AA2014 FSW welded joints related to trial conditions with square tool pin profile

Trial No	Trial condition			UltimateTensile Strength
	Rotational Speed (rpm)	Welding Speed (mm/min)	Tool Offset (mm)	(MPa)
1	700	20	0	103.99
2	1000	20	1	143.43
3	1400	20	-1	104.43

Conclusion

FSW was performed on AA2014-AA6082 alloy with a square tool and joint performances were compared under different rotational speed keeping feed as constant as 20mm/min. The study established following conclusions. The Square threaded pin with a rotational speed of 1000 rpm exhibits better tensile strength, 143.43 MPa. Tensile strength increases with rotational speed and then decreases. The maximum bending strength obtained in the stir zone of this welded joint as 282.17 MPa and the lowest one obtained at 1400 rpm in comparison. The low Tensile and flexural strength for the joint at 1400 rpm may be due to enhanced mixing action of square tool profile and tunnel defects at the joint.

References

[1]. R. Al-Sabur, H. I. Khalaf, A. Świerczyńska, G. Rogalski, and H. A. Derazkola, "Effects of Noncontact Shoulder Tool Velocities on Friction Stir Joining of Polyamide 6 (PA6)," Materials (Basel)., vol. 15, no. 12, 2022, doi: 10.3390/ma15124214.

[2]. F. Zhang, X. Su, Z. Chen, and Z. Nie, "Effect of welding parameters on microstructure and mechanical properties of friction stir welded joints of a super high strength Al-Zn-Mg-Cu aluminum alloy," Mater. Des., vol. 67, pp. 483–491, 2015, doi: 10.1016/j.matdes.2014.10.055.

[3]. N. Babu, N. Karunakaran, and V. Balasubramanian, "A study to estimate the tensile strength of friction stir welded AA 5059 aluminium alloy joints," Int. J. Adv. Manuf. Technol., vol. 93, no. 1–4, pp. 1–9, 2017, doi: 10.1007/s00170-015-7391-9.

[4]. Asmare, R. Al-Sabur, and E. Messele, "Experimental investigation of friction stir welding on 6061-t6 aluminum alloy using taguchi-based gra," Metals (Basel)., vol. 10, no. 11, pp. 1–21, 2020, doi: 10.3390/met10111480.

[5]. K. K. Jangra, N. Sharma, R. Khanna, and D. Matta, "An experimental investigation

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 06 June 2024
Page No: 1578- 1581
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0216

and optimization of friction stir welding process for AA6082 T6 (cryogenic treated and untreated) using an integrated approach of Taguchi, grey relational analysis and entropy method," Proc. Inst. Mech. Eng. Part L J. Mater. Des. Appl., vol. 230, no. 2, pp. 454–469, 2016, doi: 10.1177/1464420715578182.

[6]. K. K. Kumar, A. Kumar, and M. V. N. V. Satyanarayana, "Effect of friction stir welding parameters on the material flow, mechanical properties and corrosion behavior of dissimilar AA5083-AA6061 joints," Proc. Inst. Mech. Eng. Part C J. Mech. Eng. Sci., vol. 236, no. 6, pp. 2901–2917, 2022, doi: 10.1177/09544062211036102.

[7]. X.Zheng. Microstructure and mechanical properties of friction stir welded 7A04 high strength aluminum alloy. South China University of Technology, 2015.

[8]. H. Zhang. Study on welding technology and joint mechanical propertied of 7N01 aluminum alloy. South west Jiao Tong University, 2015.

[9]. K. Zhang, W. Zhang, D. Zhang, Q. Chen. Influence of Welding Speed on Microstructure and Mechanical Properties of 6082-T6 Aluminum Alloy FSW Joints. Hot Working Technology, 2017, 46(01): 65-68+73.

[10]. W. Yan, D. Zhu, H. Liu. Experimental investigation of 7050-T7451 aluminum. Transaction of the China the welding institution, 2009, 30(8): 109-112