



International Journal of Intellectual Advancements and Research in Engineering Computations

Experimental analysis of welding parameters of dissimilar al alloys by FSW & TIG welding

B.Sakthivel¹, C. Ragul², M. Sabarinathan², B. Venkatesh², M. Vignesh²

¹Assistant Professor, Department of Mechanical Engineering

²UG Students, Department of Mechanical Engineering
Nandha Engineering College, Erode-52, Tamil Nadu, India

ABSTRACT

Friction Stir Welding (FSW) produces higher quality welds with fewer defects like porosity, and cracking and material properties closer to the parent metal as compared to most other welding processes. A solid state process which is particularly suitable for welding aluminum. The Friction Stir Welding (FSW) can overcome the difficulties in conventional welding of aluminum alloys. A non-consumable tool is used to generate frictional heat in the abutting surfaces. A shoulder and a pin are the important parts of the tool. This tool makes weld without conventional defects with good mechanical properties and is especially suited for defense applications. The aim of present study is to determine the difference between the hardness and tensile strength of the aluminum alloys Al7075 and Al6061 with 6mm thick plates and to compare the FSW welding with TIG welding of the same materials.

Keywords: friction Stir Welding, Dissimilar Welds, AA7075, AA6061, Cylindrical Tool Pin.

INTRODUCTION

Friction stir welding (FSW) is a modern solid state welding processes that was invented and experimentally proven at The Welding Institute. It involves a cylindrical shoulder tool with a profiled pin which is rotated and thrust quickly into the area to be joined between two pieces of plate or sheet material. . The different speeds of tool rotational have been used to weld the joints. . Friction stir welding was performed at different combinations of speeds of tool rotation and welding speeds. The tensile strength, hardness and elongation were used to characterize the samples. It was concluded that increase in speed of welding is proportional to the tensile strength. The confirmation tests were made to confirm the results were under the best identified conditions. The current study aims to obtaining the best parameters

of FSW welding which are speed of tool rotation, speed of welding and pin geometry.

Investigated about friction stir welding using aluminium alloys. They analysed the major role of weld quality using the parameters are tool, rotational speed, welding speed, axial force etc. They concluded that the working range of process parameters gave defect free joints. They had a confidence level at 95%. The values were decreased after reaching a max level. But they got negative output due to the increase in welding speed. [1]

Investigated and processed about the parameters on friction stir welding using aluminium alloys. It was evident that the friction stir welding is possible for dissimilar welding. The process parameter were optimized and ranked of parameter based on the signal to noise ratio values. FSW had been many notable advantages over

Author for correspondence:

Department of Mechanical Engineering, Nandha Engineering College, Erode-52, Tamil Nadu, India

fashion welding in order to get good strength. They had been observed all the pins preferred wore broken due to high rotational speed and load level been applied. Then they selected the rotational speed factor, travel speed factor & till angle factor. [2]

Studied about friction stir welding. They analysed that if was used for welding of harder metals which may include composites & plastics. They attracted reaches for abundant advantages over conventional welding process. They derived heat generation by friction & plastic deformation. They employed four types of tool pin profiles in different input process parameter with 600 & 800 rpm rotational speed. [3]

Investigated about Friction stir welding (FSW) a welding process in which metal were joint by melting then at their solid state. It increases the weld quality which observed under various mechanical testing by using different tool size. They analysed that in welding process the metals were metal up to the joining interface to become a strong joint & brazing do not involve melting of metals. They said FSW technique is a energy depthless, eco-friendly, & versatile. They concluded that after experiments different image of weld microstructures was taken with two different kinds of microscopes. Compound microscope has given different magnification. [4]

Investigated about the experimental study on dissimilar friction stir welding of aluminium alloys to investigated the mechanical properties. They analysed that in this process the design and

selection of FSW tool pin profile was vital to produce weld joints with higher mechanical properties. FSW founds various applications in diverse sectors of industry, body shop, marine, rail and road vehicles, and containers for nuclear applications. The FSW was be carried out on the selected alloys to determine and compared the mechanical properties under constant process parameters. The universal testing machine [UTM] of 400kn capacity has been used to conduct tensile and results. [5]

Investigated on influence of tool shoulder diameter [D] to plate thickness [T] ratio on FSW of dissimilar aluminium alloys. They analyse that welding of dissimilar materials was carried over a large basis as benefits from both the materials can be derived from within a single structure. [6]

Investigated on friction stir butt welded aluminium 6061-T6 alloys using taguchi L9 experimental approach. They analyse that welding could be defined as the process for the joining of different materials by the application of heat, with or without the application of pressure and with or without the use of a filler material. A many number of welding techniques had been developed and that can be classified by means of sources of heat that is flame, arc, energy, beam, contact resistance, reactions and also by mean of types of interaction i.e. liquids and liquids interaction. The tensile hardness and tensile properties were been assessed for the welded joint. FSW of aluminium was becoming an ever more mature technology with numerous commercial applications. [7]

Table.1 Chemical composition of alloying elements in the aluminium alloys (in wt. %)

MATERIALS	Mg	Si	Mn	Cr	Ni	Fe	Ca	Cu	Zn	Ti	Al
AA7075	2.40	0.25	0.10	0.23	----	0.20	----	1.49	5.59	0.07	Bal
AA6061	0.92	0.60	0.06	----	0.18	0.33	0.2	----	0.03	0.02	Bal

Table. 2 Mechanical properties of aluminium alloys AA7075 and AA6061.

Material	UTS (Mpa)	YS (Mpa)	ELONGATION (%)	Hardness(VHN)
AA7075	543	444	6	80
AA6061	310	276	12	107

EXPERIMENTAL SETUP

The work piece must be clamped in a heavy duty setup, so that it does not move or shake at the time of welding. The work piece should be

abutting i.e. both parts should be kept side to side at a particular distance from each other .Then insert a tool till the whole pin get inserted in the abutting edges. Now the shoulder gets in touch

with the abutting edges. The tool starts rotating within the contact with the job. Due to contact of work piece, friction is applied and a result of it heat is generated. This heat makes the metal plastically melt. When the metal gets plasticized melt. When the metal gets plasticized the high downward forces or pressure makes a strong, clean and solid state weld.

RESULTS AND DISCUSSION

Process Parameters

The variation of normal load, traverse load, and spindle torque with respect to time during the experimental trials for FSW of AA7075 AA6061 is done. A detailed description of the dynamics of variation of load (both normal and traverse) and torque during the FSW of AA7075 is given. From the friction stir welding experiments for dissimilar combination of AA7075 and AA6061, it was noticed that the normal load experienced by the tool varied in the range 3.5–4kN at rotation speed of 1120rpm. Whereas at a higher rotation speed of 1400rpm, the normal load was found to decrease and was in the range 3.5–6kN. It was found that during FSW AA7075-AA6061 trials, the normal load was less at higher rotation speed of 1400rpm. However no conclusive statement can be made for the normal load at rotation speed of 1120rpm. The spindle torque decreases with an increase in the rotation speed. Further, it was observed that for a particular rotation speed, the spindle torque was not affected with the variation in traverse speeds.

Mechanical Properties Evaluation

Hardness

The variation of hardness across the transverse cross-section of FSW AA7075 and AA6061 specimen in the mid thickness region along line. A transition across the AA7075 and AA6061 interface in the nugget was observed as one proceeds from the AA7075 towards AA6061. Hence any possible smooth change (transition) in the hardness was not observed using the indentation technique. The hardness values

remained nearly constant. In an earlier work reported by the authors on FSW of AA7075, it was observed that there was a slight increase in the hardness on the advancing side.

Tensile Testing

The results of the tensile tests of FSW AA7075-AA6061 are shown in the Fig 1. The process parameters have been arranged in the decreasing order of the weld pitch (ratio of traverse speed to rotation speed expressed in mm/rev) implying that the heat input increases as one advances from the left to right. The process parameters on the left result in lower heat input whereas the process parameters on the right have higher heat input. It was noticed that the lowest heat input resulted in inferior tensile properties compared to the other specimen. The rest of the specimen gave good indication of strength where the ultimate tensile strengths were comparable and the values of the yield strengths were in the range of 135–150MPa. It was observed that the process parameters with high heat input resulted in good ductility. Overall, it was observed that the use of higher rotation speeds (1400rpm) was essential to provide Good heat input and the welds thus obtained had good tensile strength. The results for the tensile testing of FSW AA7075 and AA6061 specimen were found to be consistent with the results obtained.

CONCLUSIONS

Friction stir welding of dissimilar materials AA7075 and AA6061 was successfully performed. It was observed that at higher rotation speeds, then normal load and spindle torque requirement decreased. There was an abrupt change in the hardness across the interface. Then the comparison between the TIG welding and the FSW welding of Al7075 and Al6061 is also done successfully using the hardness and the tensile test. The tensile properties of the FSW AA7075 & AA6061 specimens were better than the properties of the softest of the similar friction-stir-welded systems (i.e., FSW AA6061)

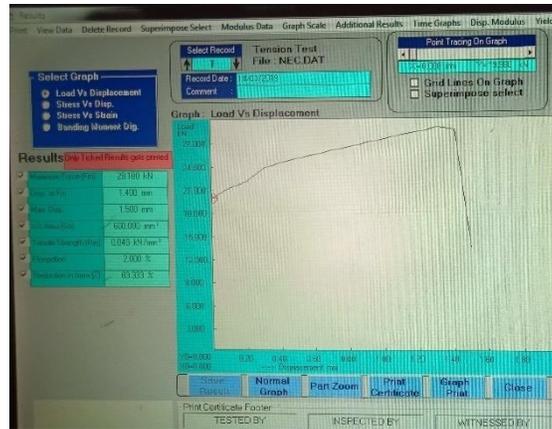


Fig 1. Tensile test of AA7075-AA6061

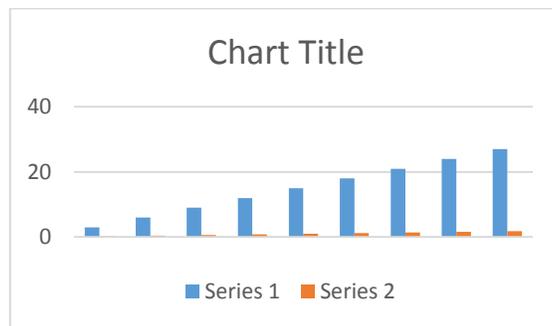


Fig 2. The % elongation, ultimate tensile strength (UTS), and yield strength (YS) for various combinations of process parameters for friction-stir-welded AA7075-AA6061 specimens

REFERENCES

- [1]. K.Anganan, R.J.Narendran, N.Naveen Prabhu, R.Rahul Varma, R.Sivasubramaniyam. "Experimental analysis on mechanical properties of friction stir welding in dissimilar aluminium alloys". IJAICT, 4, 2018, 1286 – 1295.
- [2]. J.Murali, K.T.Thilagham, P.Sundararaj. "Optimization of process parameters on friction stir welding of aluminium alloys". International research journal of engineering and technology [IRJET]. 5, 2018, 2492-2499.
- [3]. Jitenderkundu, Gyanderhangeas, Nav Rattan, Sathis Kumar Sharma. "Effect of different parameters on heat generation and tensile strength of FSW joints". International research journal of engineering and technology [IRJET]. 7, 2017, 2347-5161.
- [4]. Amit H.Karwande, Seeram Srinivasan Rao. "Welding parameter optimization of alloy material by friction stir welding using taguchi approach and design of experiments". International research journal of engineering and technology [IRJET]. 3, 20115-1 – 20115-9.
- [5]. H M Anil kumar. V Venkata Ramana and mayor Pawar. "Experimental study on dissimilar friction stir welding of aluminium alloys to investigate the mechanical properties". International research journal of engineering and technology [IRJET]. 3, 2018, 012076-1 – 012076-9.
- [6]. Srirangam Adithya Vamshi, M.S. Srinivasa Rao, S.N.S. SaiHari. "Experimental Investigation on Influence of tool shoulder diameter to plate thickness ratio on friction stir welding of dissimilar aluminium alloys". 5, 2018, 2395-0072.
- [7]. D.Maneiah, K. Prahlada Rao, K. Brahma Raju. "Experimental investigation on friction stir butt welded Aluminium Alloys using taguchi L9 experimental approach". Advanced Materials Research. 1148, 176-186.