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Study on Mechanical Propreties of Friction Stir Welded Dissimilar AA2024 and AA7075 Aluminum Alloy Joints

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Abstract

The joining of dissimilar AA2024 and AA7075 aluminium plates of 6 mm thickness was carried out by friction stir welding (FSW) technique. In the present investigation, the high strength AA2024 T3 and 7075-T6 were welded by the FSW process. To certain the optimal mechanical properties by varying the rotational speed from 900 to 1400 rpm and welding speed between 30 to 60 mm/min. This work was aimed at studying the mechanical properties in dissimilar aluminum alloy joints. In this experimental the testing of mechanical properties input parameters, for example rotational speed, tool speed and axial force with appropriate welding parameters and the mechanical properties of FSW dissimilar aluminum alloy AA2024 and AA7075 has tested with the assistance of general testing machine, Higher mechanical properties are gotten with square pin profile tool at a rotation speed of 1400rpm and welding pace of 60mm/min. The test results revealed that sound imperfection free joints could be acquired when the high quality AA2024. The rigidity was enhanced at high heat input.

KEY WORDS: Friction stir welding, dissimilar joint of Al alloys, impact test, tensile properties.

INTRODUCTION:

Aluminum alloy is light weight, softer, tendency to bend easily, cost effective in terms of energy requirements so aluminum alloy has selected in this FSW technique. The heat provided by the fusion welding processes is responsible for the decay of

mechanical properties of AA2024 due to phase transformations softening is introduced in this alloy [1-3]. The arrangement of brittle structure in the weld zone prompts the radical decrease in the mechanical properties like brings down in hardness, strength and malleability [4-5]. Cavaliere et al. [6] investigated the tensile behavior of dissimilar FS welded joints of aluminum alloy 2000 and 7000 series and both the ultimate strength and elongation of the dissimilar joints are lower than both the base material. Hence, the present research work is aimed at understanding the friction stir welding process parameters on AA2024-T3 and AA7075-T6 dissimilar joints and their influence on mechanical properties especially hardness gradient and tensile properties.

EXPERIMENTATION

Initially a base metal (BM) sheet of 6mm thick 2024-7075 Aluminum alloy was welded as a butt joint with a rotating tool probe assembly by Vertical Milling Machine (VMM). These base metals of aluminum alloy have good weld ability, very good corrosion resistance and have the highest strength of the non-heat treatable. H13 tool steel is selected as tool material due to low wear resistance, great strength at elevated temperature and thermal fatigue resistance.

The diameter of the shoulder was 24mm and pin 8mm used. Length of the pin was 4.7mm. A constant axial force was 5 KN applied and tool onward tilt angle was20 for all the FSW experiments and the schematic sketches are shown in figures 1. Experiments were conducted with different tools (taper threaded, square, taper conic) shown in figure 2, on 2024-7075 Aluminum alloy with a different tool rotational speeds of 900rpm, 1120rpm and 1400 rpm and also welding speeds of 60, 31.5 and 40mm/min correspondingly. A cryogenic (liquid nitrogen, dry ice) is applied to the plate immediately behind the FSW tool for rapid cooling.

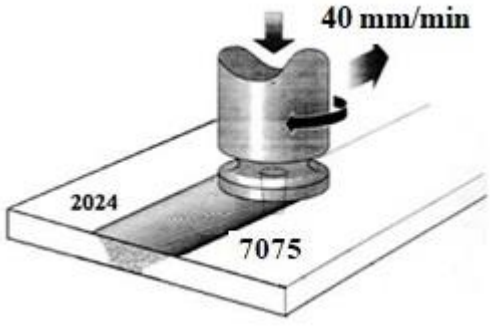


Figure 1: FSW process of 2024-7075 aluminium alloys

Figure 2: Three different types of tools

Base Materials:

The base materials used in the present study is Al 2024-Al7075 alloy plate with 5mm thickness. Aluminium 2024 alloy has good machinability and surface finish capabilities. Al 2024 is high strength material of adequate workability and largely used for structural applications where as Al 7075 has very high strength material used for highly stressed parts and offers improved corrosion cracking resistance. Al2024-Al7075 has a density of 2.78 g/cm^3 and 2.81g/cm^3.The typical composition of materials Al 2024-Al7075 are shown in Table 1.

Table 1: Chemical composition of Al2024 and Al7075 alloys:

CHEMICAL ELEMENT	Manganese (Mn)	Iron (Fe)	Copper (Cu)	Magnesium (Mg)	Silicon (Si)	Zinc (Zn)	Chromium (Cr)	Titanium (Ti)	Aluminium (Al)
Al 2024 wt%	0.3-0.9	0.50 Max	3.8–4.9	1.2-1.8	Max 0.5	0.25 Max	Max 0.1	0.15 Max	90.7-94.7
Al7075 wt%	Max 0.3	0.50 Max	1.2-2.0	2.1-2.9	Max 0.4	5.1-6.1	0.18– 0.28	0.2 Max	87.1-91.4

Tensile Test:

A Tensile test mostly named as tension test is probably the fundamental type of mechanical test that can perform on material to determine/verify material properties. It is an ability to predict the loads that will cause a part to fail depends upon both material properties and the machine part geometry. The tensile specimens are prepared as per the American society for Testing of Materials (ASTME 8M-04) standards. The tensile tests were carried out at room temperature using a Universal Testing Machine (Make: FIE, India). The tensile specimen of Al plate with dimensions of 100 mm in length, 10mm in breadth and 6 mm in thickness was prepared shown in figure 3 and figure 4 represents the specimens before conducting test. The emery papers were used to polish the test specimens in order to decrease the machining scratches and the effects of surface defects on the sample. Tensile specimens were machined from the NZ in two directions from the weld: parallel (longitudinal) and normal (transverse). The strain analysis of each specimen was made by an ASTME automatic strain measuring system. The tensile properties of the joints were evaluated using three tensile specimens cut from the same joint.

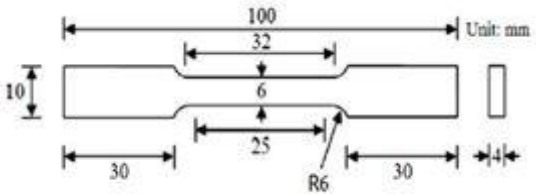
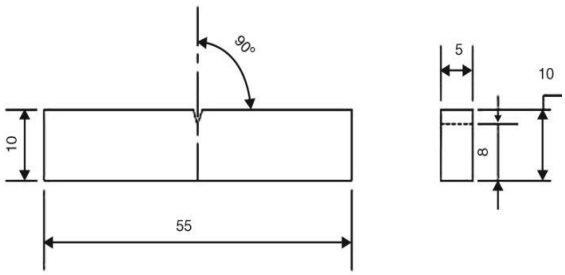


Figure 3: Tensile test specimen cutting nomenclature **Figure 4: Tensile specimen before Testing**

Impact Test:

The Charpy impact test is a dynamic test in which a test piece U-notched or V-indented in the center and upheld at each end, is broken by a solitary blow of an openly swinging pendulum. The energy retained is measured. This retained vitality is a measure of the effect quality of material. The Charpy V-notch Test is very common and the impact specimens shown in figure 5 are tested at a series of specified temperatures in the range of -452ºF to 500ºF. The FSW Al2024 and Al7075 material is cut in the required dimensions shown in figure-6 at the stirred portion. The specimen breaks at its notched cross-portion upon affect, and the upward swing of the pendulum is used to choose the measure of energy retained (indent durability) at the same time. energy absorption is straight forwardly related to the delicacy of the material.



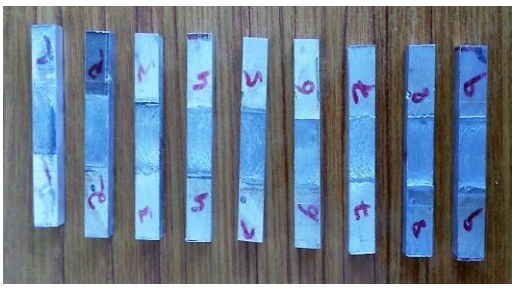


Figure 5: Impact test specimen dimensions **Figure 6: Impact test specimen before testing**

RESULTS AND DISCUSSIONS

Tensile properties:

In any welding, the heat input plays an important role on the tensile properties of the weldments. The particular weld input energy for FSW might be gotten by the

proportion of the rotational speed to the welding speed. From the experimental results it was found that an extreme rigidity extended with increase in weld speed in the tested range. Extreme rigidity was seen at the blend zone of Al 2024 and Al7075 weldments at steady tool rotation speed and traverse speeds, such as 900, 1120, 1400rpm and 31.5mm/min individually. The joint fabricated by taper threaded profile tool exhibits high tensile strength when compared with the other joints due to sever plastic deformation takes place during stirring and flow of the material from retreating side to advancing side is good compared to other tool pin profiles. The joint fabricated by taper conic tool pin profile has the least tensile strength. The experimental results observed from the test are given in the below table-2 and tested specimens are shown in figure 7

Table 2: Tensile strength of welded Al2024 and Al7075 alloys.

Specimen no	Speed	Tool profile	Ultimate tensile stress	Elongation percentage	0.2% proof stress
1	900	Taper Threaded	306.263	5.63	281.180
2	900	Taper Threaded	281.832	4.67	243.701
3	900	Taper Threaded	318.449	6.53	284.021
4	1120	Square	282.802	7.12	244.321
5	1120	Square	267.347	5.04	237.107
6	1120	Square	234.593	3.94	199.849
7	1400	Taper conic	262.610	4.93	214.598
8	1400	Taper conic	281.895	4.45	238.818
9	1400	Taper conic	210.243	3.77	184.129

Figure 7: Tensile test specimen after testing

Impact Test:

impact testing most ordinarily comprises of Charpy led on instrumented machines equipped for measuring under 1 foot-pound to 300 foot-pounds at temperatures extending from - 320°F to more than 2000°F. The reason for affect testing is to quantify a protest's capacity to oppose high-rate loading. It is typically thought of as far as two objects striking each other at high relative paces. The capacity to measure this property is an extraordinary preferred standpoint in product liability and security. The FSW joints of Al 2024 and Al 7075 exhibits impact energy of 9J and the test specimens are shown in figure 8.

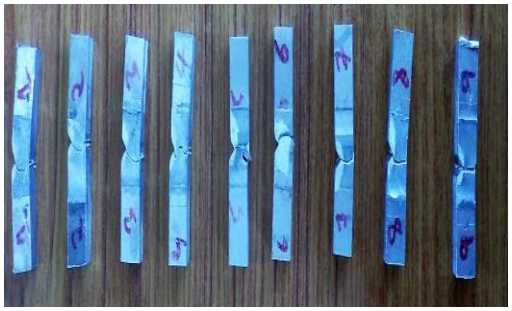


Figure 8: specimen after conducting impact test

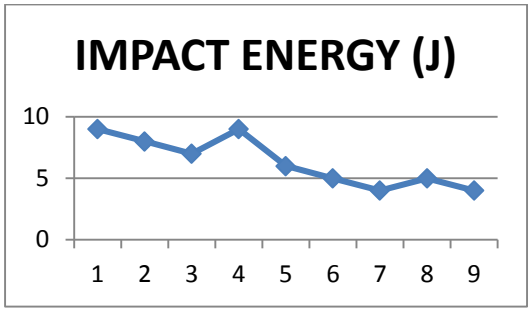


Figure 9: Impact energy of specimens

CONCLUSION

The present experimental study on understanding the affect of the process parameters of FSW on AA2024-AA7075 aluminum alloy. As per my experimental study I will conclude that.

- The higher tensile strength 318.449 Mpa of the dissimilar friction stir welded joint was obtained under a welding speed of 31.5 mm/min for the tool rotation speed of 900 rpm with taper threaded tool.
- The travel speed in FSW affects the tensile strength of the joint. Increasing the travel speed tends to increase the tensile strength of the friction stir welded joint.
- The hardness distribution in the SZ is slightly affected by welding speed and the hardness values varied from 132.6 to 158.1 Hv due to the presence of intermetallic compounds formed by either 2024 Al alloy or 7075 Al alloy.
- The hardness of the base metals affects the weldability of either Al2024 alloy or Al 7075 alloy joined by FSW.

- In case of dissimilar joints 2024 Al alloy and 7075 Al alloy, increasing welding speed led to redistribution of phases in the stir zone.
- The impact energy of the FS welded specimen exhibits the range of 4J - 9J.

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REFERENCES

[1] J. H. Ouyang and R. Kovacevic, Material Flow and Microstructure in the Friction Stir Bitt Welds of the same and Dissimilar Aluminium Alloys, J. Mater. Eng. Perform., **11**, 51-63 (2002).

[2] P. Cavaliere, A. Squillance and F. Panella, Effect of Welding Parameters on Mechanical and Microstructural Properties of AA6082 Joints Produsedby Friction Stir Welding, J. Mater. Process. Technol., **200**, 36472 (2008).

[3] V Guillaumin and G. Mankowski, Localised Corrosion of 2024-T351 Aluminium Alloy in Chloride Media.

[4] C. G. Rhodes, M. W. Mahoney and W. H. Bingel, Effects of Friction Stir Welding on Microstructure of 7075 Aluminium, Scripta Mater., **36**, 69-75 (1997)

[5] P. Cavaliere, E. Cerri and A. Squillace, Mechanical Responce of 2024-7075 Aluminium Alloys Jointed by Friction Stir Welding, J. Mater. Sci., **40**, 3669-3676 (2005).

[6] P. Cavalier and F. Panella, Effect of Tool Position on the Fatigue Properties of Dissimilar 2024-7075 Sheets Jointed by Friction Stir Welding, J. Mater. Process. Technol., In Pres, Doi:10.1016/j.jmatprotec.2007.12.036 .