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Analysis of Mechanical Properties of AA2014 and AA7075 Dissimilar Metals Using Friction Stir Welding

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Abstract

A efficient method of entering the state is the Friction stir welding (FSW).The joining temperature is lower than that and the phase used Inside the types of Welding via selection. With this one way, FSW is deemed to have give over combination welding, a few focal points for separate metal with welding. This research focuses on the impacts of material location and rotational speed on tensile strength. This study focuses on the latest test of the unit. For the welding process, material alloys for AA2014 and AA7075 are selected. The welded ones aluminium compounds are materials6.0 mm thick and are not used by conventional manufacturing equipment. Three sets of Varying rotational speeds have created joints of the system and by replacing the fixed situation on advancement and progress with drawing sides of the material. The study found that If AA7075aluminium amalgams with clear surface appearance and no surface appearance were set at a rotational speed of 1000 rpm on the propelling side. internal deformity over welding region, the greatest rigidity of 207 MPa has been achieved sample for sample C, while the most reduced elasticity was 160 MPa when it was AA7075,mounted on the retreating side with extreme passage deserts in the welding field contributing spread to be divided, it was obtained for sample A. Along these lines, more fragile materials should on the propelling hand, set it in specific welding to cause warmth from the revolution of the instrument and smoothness of the arrangement of the stream of content in the mixed region.

Keywords: welding with Stir up friction, rotation speed speeds, aluminum alloys, tensile toughness.

1. Introduction.

Friction welding is the welding process in which friction between the ends of the two components to be combined selects the heat provided for welding. One of the components to be joined is rotated at a high velocity similar to over 3000 rpm and the second component is axially aligned with the second portion part and securely pressed against that. The temperature at both ends is lifted either by friction between the two electrodes. The piece's rotation is then instantly suspended and the friction is increased in order for the joining to occur on the fixed portion. This is also known as Welding friction. Since the joining is carried out with the welding, friction welding could be treated as forge welding pressure application. In friction welding, because of it's friction between two surfaces to be joined, the heat desired for the welding process is created. It is able to make enough heat and record the pressure of the mating point the degree at which the surfaces are subject to friction can be completely clamped together.

A selection of the phases of solid state occur during using frictional friction welding energy consumed by the Straight forward communication between moving pieces of job, with the addition of a swaging force between the two work pieces to plastically diffuse material. It is able to integrate some generic material combinations and there are a number of techniques in welding of smaller pieces by friction may also be performed with adequate settings for clamping and fixtures and machining using the center lathe, but special machines have to be used for bigger sections. That's because the availability of power in a lathe might not have been sufficient to rotate a larger part at the amplification conditions and to provide axial strength applied for friction welding to be sufficient.

2. Literature Survey

R. Plaintively et al., [1] developed the analysis technique for measuring the maximum tensile force of the aluminium alloy it was AA5083-H111, that is frequently used in the shipbuilding industry sectors either via implementation of the phase of friction stir welding (FSW). Three factor five level central composite rotatable designs with total replication technique were kept in mind in the process. To create the model of linear regression to develop the relation between the parameters of both the FSW process and the ultimate tensile intensity, response surface methodology was used. The process parameters are tool rotational speed, welding speed, and axial force. To maximize the ultimate tensile power, the FSW process parameters were also optimized using response surface methodology (RSM).There is a working set of tailored welding parameters for high quality AA5083-H111 aluminium alloy welded joints.

Rizal Rose et al., [2] found that the predominant justification for the greater hardness and the higher hardness, suitable the tensile features of these joints is the creation fine grains in the stir-up region. In this, the joints were built employing five different welding velocities from 30 to 150 mm/min range. the material is AZ61A Magnesium Alloy. The process parameter welding speed is used to find out the impacts friction stir welding pace welded AZ61A magnesium alloy tensile properties. Macrostructure, Fracture surface analysis, Macro hardness, Micro hardness and tensile test was performed to find out the influence of welding speed on tensile properties of AZ61A Magnesium Alloy. It is found the joints are made at a welding speed of 90 mm/min, a rotation speed of 1200 rpm and an axial force of 1200 rpm at 5KN.Compared to other joints, it showed a maximum tensile strength of 224MPa (83 percent of base metal).

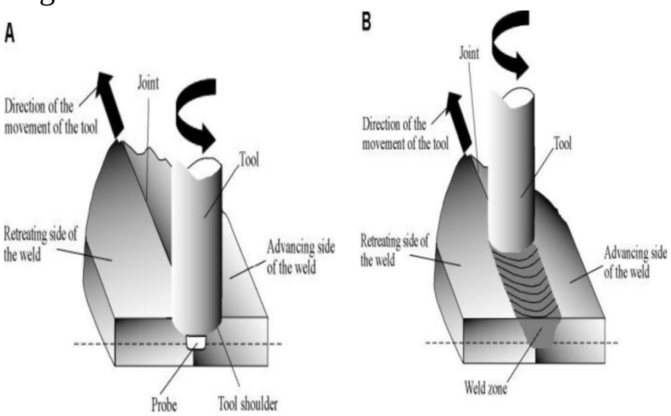
Jaya Raman et al., [3] have made the start to study the effect of FSW process parameters on the tensile power of welded together. The material used is cast A319 aluminium alloy. The process parameters tool rotation, welding speed, and axial force were chosen to analyses the tensile strength of welded joints. Tool made of cylindrical shoulder with cylindrical pin was used. Macrostructure, Fracture surface analysis, Macro hardness, Micro hardness and tensile test were performed to find the influence of process parameters on tensile strength. It is found that, joint fabricated Compared with other joints, the 1200 rpm tool rotation speed, 40 mm/min welding speed and 4 KN axial forces demonstrated superior tensile strength.

3. Friction stir welding operating theory

Friction stir welding for welding is conducted along a reciprocal boundary by translating or rotating one element close to another, while smearing a compressive force through the joint. Both parts are relaxed by the frictional heat at the boundary and the border material is extruded from the ends of the combined material once they are altered. In order to get from each module to the new one, fresh material design. Then the relative cue is stopped, and The key the friction welding element is that, as the weld is generated in the solid state itself, no liquefied solid is developed.

The theory of this approach is the transformation by friction kinetic energy (rotational or translational) energy can be converted into heat energy. One piece is fascinated by its axis and revolves around it, while the other component revolves around its absorbed and not rotated, however it can be axially relocated in order to build contact at the aspect of upon spinning. When the temperature of fusion is reached, the gyration is obstructed and the smeared forging friction is forged. Due to friction, the heat at the edge is produced, concentrated and stored. The grain structure was polished by scorching effort. The joint is then generated, but no material melting occurs.

The components to be welded are brought into contact briefly in the friction-welding process, when one of them was stationary and the other was rapidly rotated around its axis. the heat created once at the boundary for solid phase welding, rubbing is plentiful without the melting, it's the turning finished. clogged together and applied under tension, the components manufacture confined forging that achieves close joining and also removes all surface impurity and some of them distressed solid known flash at that joint.
One part was swapped for friction welding and another part was seized motionlessly. The chunk that was rotated connected to the motionless component and rotation is obstructed when ample heat was produced to carry the components at a plastic stage and then desired burn-off is achieved. It is then smeared with more axial tension between both modules, leading to a solid-state connection at the level of the boundary. Build together for friction. Fig.1 shows that one piece is rapidly rotated, and other is immobile,rotating components are interacted and load was applied together, axial loadwas intensified for components to fetch at the boundary in plastic state, rotation is obstructed and further load is applied, as a result of a complete in the parent solid cross sectional weld as shown in Fig. 1



Figs 1 Principle of friction stir welding

4. Work Materials

4.1Aluminium 7 Series (7075)

Aluminium alloy 7075 contains 2.1-2.9% Magnesium, manganese by 0.3 percent and chromium by 0.18-0.28 percent. It is efficient in the tempered state, and retains strong ductility, strong resistance, and hardness. 7075 has good resistance with respect to corrosion, and one of the most significant widely used alloys there has been extensive use of extremely stressed structural applications in the structural parts of aircraft.

4.2 Typical Applications

Owing with their excessive specific strength, like transport applications, shipping, automotive and aviation, series alloys such as 7075 are also used.. These same characteristics apply to the use of 7075 aluminium alloy in rock climbing equipment, bicycle components, inline skating frames and hang glider airframes.

4.3 Chemical Compositions

Table 1 chemical properties

Element	%
Aluminium	Remainder
Magnesium	2.1-2.9
Manganese	0. 3
Chromium	0.18-0.28
Silicon	0.4
Zinc	5.1-6.1
Copper	1.2-2.0
Iron	0.5
Titanium	0.2

4.4 Mechanical compositions

Table 2 Mechanical properties

Property	Value
Proof Strength	145 MPa
Tensile Strength	220 MPa
Elongation	17 %
Shear Strength	150 MPa
Hardness Vickers	175 HV

4.5 Aluminium 2 Series (2014)

By forging at 390 °C in two stages, the AA2014 alloy was made. The specimens were then heat treated with various parameters to T6 temperature.

4.6 Usual Applications

A wieldable strong to moderate strength alloy with decent strength to corrosion was needed. Sea applications, Boats with unfired welded pressure, towers of television.

4.7 Chemical Compositions

Table 3 Chemical properties

Element	%
Aluminium	Remainder
Magnesium	2.1-2.9
Manganese	0.3
Chromium	0.18-0.28
Silicon	0.4
Zinc	5.1-6.1
Copper	1.2-2.0
Iron	0.5
Titanium	0.2

4.8 Mechanical properties

Table 4 Mechanical properties

Property	Value	
Test direction	Longitudinal	Transverse
Ultimate strength	70200 psi	71900 psi
Yield strength	61200 psi	62000 psi
Elongation	7.8	7.1

5. Welding process

Welding is done in a commercial Vertical spindle CNC machine performing milling operation. The main objective of the operation to select the machine is for the automatic feed. The automatic feed helps the machine to make the weld with high effectiveness. The programming is done to the overall operation to perform in the weld, so that the proper timing is carried out. Machine performing the weld can be done also in conventional milling machine as shown in fig.1a CNC machines.

Fig.1a CNC Machines

5.1 Specimen Making Process

Specimen making the welded plates are marked for the specimens that are cutted in the band saw machine, so that the plates are marked with suitable dimensions as shown in fig. 2 plate marked cutting.

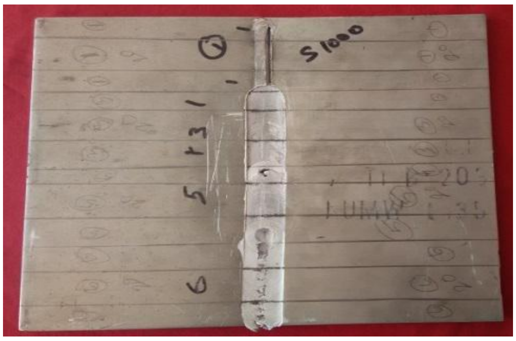


Fig.2 plate marked for cutting

The welded plates are cutted in the band saw machine and it is mostly specified for cutting without shakes and vibrations as shown in fig.3 band saw machine.

Fig. 3 band saw machine

After cutting the pieces with different experiments are segregated and the pieces are now ready for the test as shown in fig.4 after cutting pieces.

Fig.4 After Cutting pieces

6 Test results

6.1 Tensile Test

The transverse tensile properties of the welded joints presented show that, in relation to the joints for GMAW and GTAW, the FSW joints exhibit superior tensile properties. All the analyses inevitably failed to weld in the area during tensile testing. This means the welding of that area was relatively weaker than other sections and that welding controls the properties of jointregion, chemical composition and microstructure.

The majority of the specimensin the FSP failed area during the tensile examination,However the exact failure location is either at the withdrawing side (RS) or at the advancing side (AS) and is also evident from the fracture surface examination. Micro hardness calculation and micro structural analysis have been performed all joints in the FSP field displays the micro hardness values and shows the microstructure joints in the FSP manufactured for comparison purposes using 18 mm shoulder diameter tools, as shown in Fig.5.

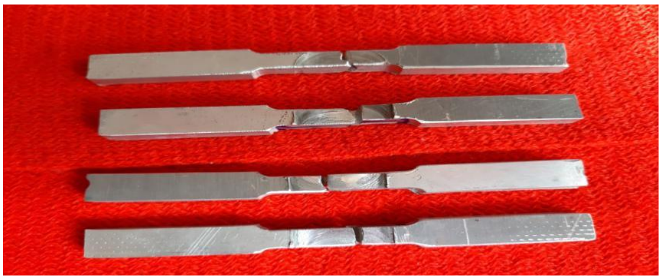


Fig. 5 After Tensile Testing Pieces

Input Data			Output Data		
Specimen Shape	: Flat		Load At Yield	: 1.129	kN
SpecimenType	: ALUMINIUM		Elongation At Yield	: 5.521	mm
Specimen Description	: Alu-2014&Alu 7075		Yield Stress	: 32.413	N/mm2
Specimen Width	: 6.08	mm	Load at Peak	: 1.358	kN
Specimen Thickness	: 5.73	mm	Elongation at Peak	: 5.872	mm
Initial G.L. For % elong	: 25	mm	Tensile Strength	: 38.966	N/mm2
Pre Load Value	: 0	kN	Load At Break	: 0.795	kN
Max. Load	: 30	kN	Elongation At Break	: 5.990	mm
Max. Elongation	: 1000	mm	% Elongation	: 1.32	%
Specimen Cross Section Area	: 34.838	mm2			
Final Gauge Length	: 25.33	mm			

CHT Rate

CHT Rate (mm/min)	Target C.H.T. (mm)	Hold Time (sec)
10	100	1

Stress Vs. Strain

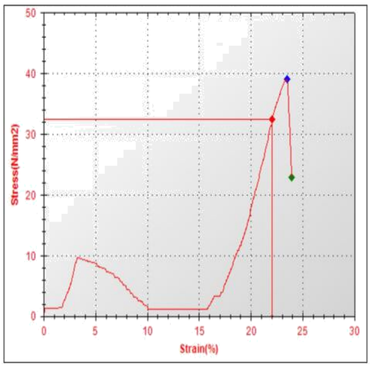


Fig. 5.1 Tensile test resut

6.2 Check for bending

A defined a universal testing machine, the test fixture is typically included in the research methodolgy for conducting the result.The outputs of the test are influenced by elements of the preparation, conditioning, and conduct of the test. The specimen isplaced on two supporting pins a set distance apart as shown in fig.6 bending machine.

Input Data			Output Data		
Specimen Shape	: Flat		Load at Peak	: 0.040	kN
SpecimenType	: Aluminum		C.H.Trevel at peak	: 0.00	mm
Specimen Description	: Alu-2014 & Alu-7075 2014 Alloy / 7075 Alloy		Shear Strength	: 0.434	N/mm2
Specimen Width	: 15.24	mm			
Specimen Thickness	: 6.05	mm			
Pre Load Value	: 0	kN			
Max. Load	: 400	kN			
Specimen C S Area	: 92.2	mm2			

Load Vs. Time

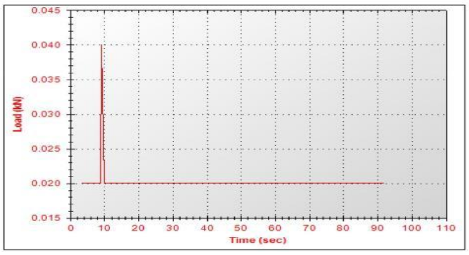


Fig. 6 After Bending Test

Conclusion

The FSW process of dissimilar aluminum alloys AA2014 and AA7075 was successfully carried out and it is possible to summarize the results obtained as follows:

- During FSW phase, theappearance of surface welding relies on the heat input that corresponds to the speed of rotation and the material position. For Group A,1000 rpm rotational velocity with AA20144 located at the advanced side resulted in stronger appearance of surface weldswith sound joints and no major faults.
- The maximum value of the tensile strength ofSample E is 207MPa compared to Sample H with AA7075 on the forward side with a minimum tensile strength of 160MPa due to extreme tunnel defects inside the element and surface galling leading to failure, with a rotational speed of 1000 rpm and AA2014 on the forward side.
- This study shows that the strength reduction area of the AA2014 at the HAZ shows that, amaterial that is weaker it determines the output of the element where failure occurred. In future research, it is proposed that the withdrawing side should be positioned with stronger materials instead of the strengthening side.

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