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Experimental Analysis of AA7079-Copper CZ101 Friction Stir Welded Joints

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ABSTRACT

Functional feasibility of application manufacturing of Friction Stir Welding (FSW) technology, high-performance, high-performance on-site, on-site, highly energy-efficient solid-state approach to design large, complex and thick-walled structures. - Temperature materials. The technological advances presented here attempt to address two fundamental problems in FSW: 1) inefficiency in in-situ weld thick section steels and 2) complexity of in-situ welding, both of which limit the widespread use of FSW in production. . As a result of this research, significant progress has been made in transforming FSW technology from a "specialist" to a "mainstream" material joining technique, allowing the industry to take advantage of its broader energy, environmental and economic benefits.

The technical development of this project is mainly focused on its intended application: solid state assembly of connecting parts. Concerns about energy conservation and environmental protection must be addressed. As vehicle weight reduction has become one of the most successful strategies, the use of composite 304 stainless steel and bronze alloy in vehicle production is increasing. In this environment, several attempts were made to weld the steel to a bronze alloy. Solid joints have not yet developed because of the strong and brittle intermetallic compounds created at the weld whenever steel is added to bronze by fusion welding. During the gas welding process, the metals are heated and as a result of this heating, the strength of the metal decreases and its microstructure changes. However, compared to gas welding, abrasive stair welding heats the metal less. The strength and structure of the metal varies less than gas welding because the metal absorbs less heat. Frictional stir welding results in a more precise microstructure and tensile strength than gas welding. In this work, the tensile strength of the microstructure, microhardness and two friction stair welded joints were compared with the gas welded joint.

1. INTRODUCTION

1.1 Welding with friction stirs:

Friction stir welding (FSW) is the process of welding two rival workpieces together in a solid state using a tool that does not melt the workpiece material. The friction between the turning tool and the workpiece material produces heat, resulting in a softened zone around the FSW tool. The tool mechanically combines two pieces of metal by mixing the heated and molten metal with the mechanical pressure of the instrument, similar to mixing clay or wheat. It is a popular choice for handcrafted or extruded aluminum and is suitable for structures that require strong weld strength. Modern shipbuilding, railway and aircraft applications all use FSW.

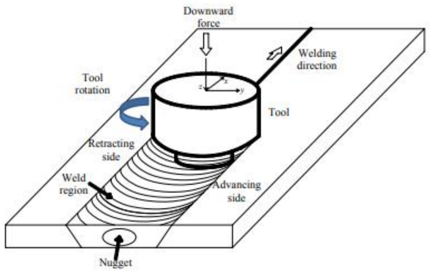


Fig. 1 – The friction stir welding process is shown schematically.

In FSW, a cylindrical stepped tool with a profiled probe is gently rotated and joined into a joint line between two adjacent pieces of sheet or plate material (Fig. 1). Friction heat is generated between the wear-resistant welding tool and the workpiece material. The hot material softens (approximately 70-85 percent at melting temperature) allowing the pin to move along the joint. The material on the front of the spinning pin is plasticized by frictional heat, which is transferred backwards as the tool rotates. Figure 1 shows the simple connections that can be made using FSW.

There are two different kinds of friction stir welding processes.

1. Welding is stirred by conventional friction.
2. Welding is stirred by self-reacting friction.

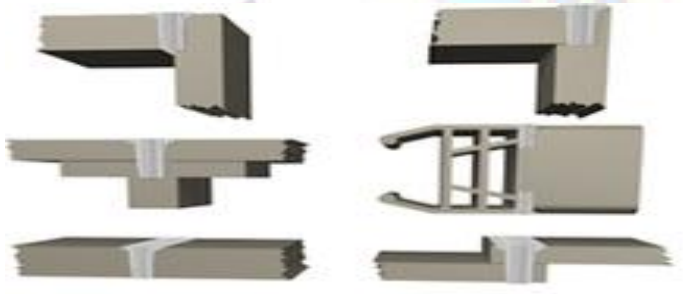


Fig. 2 – FSW joint configurations

2. REVIEW OF THE LITERATURE

[1] W.Y. Read al. In 2014, researchers studied the effects of rotation and welding speed on the microstructure and mechanical properties of the Friction Stir Welded Coil Tool (BT-FSW) Mg AZ31. According to the results, the thermomechanical impact zone (TMAZ) of the coil-tooling alloys and the Al and Mg alloys showed uniform grains. Abrasive stir-welded Al and Mg coil and tool alloys have also been found.

SU [2] Tarasov et al. The mechanism of diffusion wear in FSW tools made with steel 1.2344 X40CrMoV5-1 has been investigated from the point of view of contact with the metal and tool of the tribological membrane structure. The idea is that by cracking along the brittle grain borders created on the surface of the tool during FSW, the bits of FSW tool material will be deformed and removed from the tool.

Juan Che et al. [3], (2015) Double-sided step friction welding (DFSW) using a combination of convex and concave tools to join magnesium alloys (concave DFSW). Under ideal conditions, concave DFSW can produce precise joints and the joints have a zircon structure unique to simple, one-turn stair-friction welding. The average grain size of the control zone decreases with increasing rotational speed of the concave tool. According to this study, heat during FSW is generated not only by friction but also by plastic changes. The complex mixture flow of the convex tool randomly changes the shape of the fear zone, resulting in the desired pulling behavior.

FF Wang et al. [4] (2015) studied how speed affects the microstructure and mechanical properties of joints, as well as microstructure and tensile properties. As a result, they found that with increasing speed, the grain size of the steering zone increases and the density of frozen particles decreases; In the shoulder-dominated zone, joint line residues are greatly reduced, while in the probe-dominated zone, changes are limited. As the soft area decreases and migrates outwards, the average stiffness of the moving zone increases and the stiffness profile changes with the cross-section of the joint. As the soft area shrinks and rotates outward, the average stiffness of the excitation joint increases with rotational speed and the maximum force capacity decreases by less than 80%. The cracks start from the rest of the band line, spread to the heat-affected zone, and then extend to the boundary between the thermal-mechanical affected zone and the problem zone, resulting in three types of cracks.

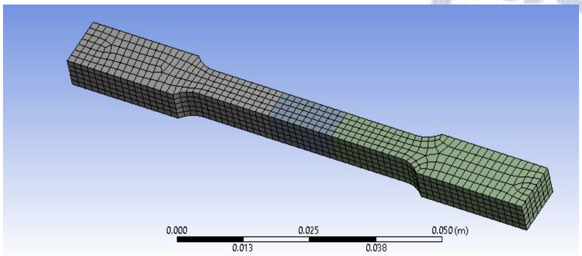
By Bincy et al. Developed a specialized welding process using specially designed friction step welding machines (FSW). According to the researchers, the weld temperature increased during the first 220 rounds of perimeter welding before stabilizing to the following 140 rounds. The surface quality, macro / microstructure and mechanical properties of the weld all respond to temperature variations around the perimeter and during welding. In the AL bulk / Cu bulk contact, none of the tested train models developed cracks. (1) brittle fracture pathways in the nugget near all bulk / c bulk contact, which extend mainly along or vertically along the nugget band structures; (2) ductile fracture in alveolar nugget with 3% ductility; And (1) brittle cracks and crevices in the nugget near the bulk al / bulk cue contact, which mostly extend along or vertically along the nugget band structures.

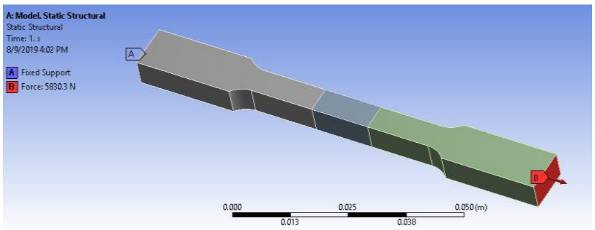
3. ANSYS

ANSYS computer software is a multipurpose finite element application used to solve a variety of engineering problems. Static and dynamic structural analysis, static and transient difficulties, model frequency and buckling eGenvalue challenges, static or time-varying magnetic analysis and all other coupled field fields and applications are handled with ANSYS. Nonlinearities or secondary effects include certain nonlinearities or secondary effects such as plasticity, high strain, hyperplasticity, creep, swelling, large displacements, contact, stress, hardening, temperature dependence, material anisotropy and radiation. This application. Substructures, submodeling, random vibration, kinetostatics, kinetodynamics, free convection fluid analysis, acoustics, magnetics, piezoelectrics, coupled field optimization and design optimization are all continuously programmed and introduced. These features enhance the flexibility of ANSYS as an analytical tool for a wide variety of engineering disciplines.

Since its inception in the 1970s, ANSYS software has been widely used in aerospace, automotive, construction, electronics, utilities, manufacturing, core plastics, oil and steel. Many companies as well as many consultancies and hundreds of organizations use ANSYS for analysis, research and education.

Mesh





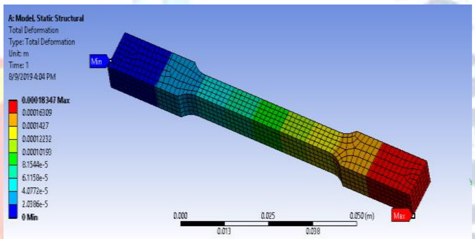
Loads

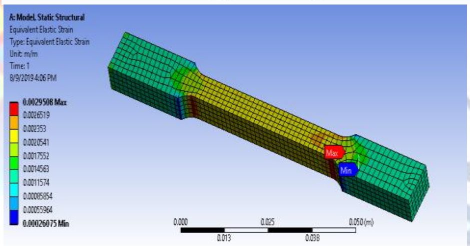
Object Name	Fixed Support	Force
State	Fully Defined	
Scope		
Scoping Method	Geometry Selection	
Geometry	1 Face	
Definition		
Type	Fixed Support	Force
Suppressed	No	
Define By		Vector
Magnitude		5830.3 N (ramped)
Direction		Defined

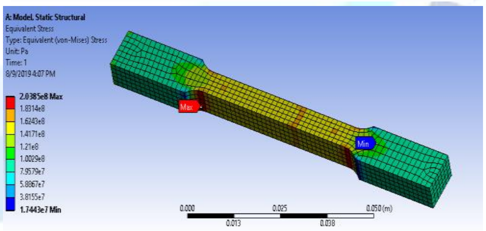
Solution

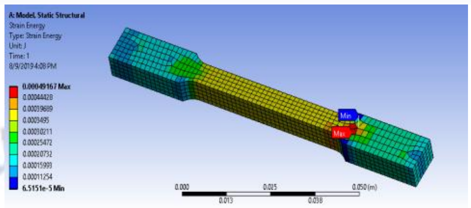
TABLE 14
Results

Object Name	Total Deformation	Directional Deformation	Equivalent Elastic Strain	Equivalent Stress	Strain Energy
Results					
Minimum	0. m	-1.8345e-004 m	2.6075e-004 m/m	1.7443e+007 Pa	6.5151e-005 J
Maximum	1.8347e-004 m	0. m	2.9508e-003 m/m	2.0385e+008 Pa	4.9167e-004 J







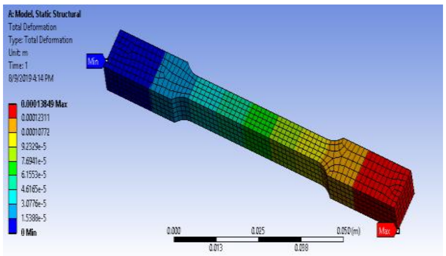


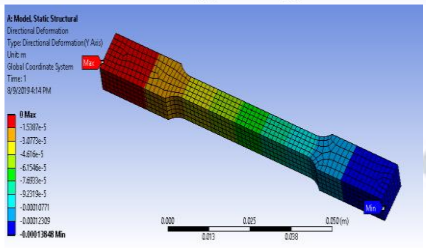
Loads

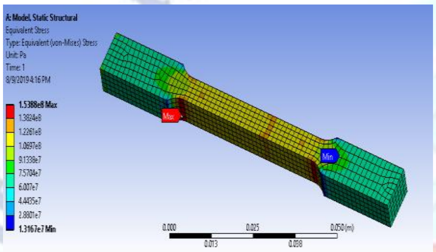
Object Name	Fixed Support	Force
Magnitude		4401. N (ramped)

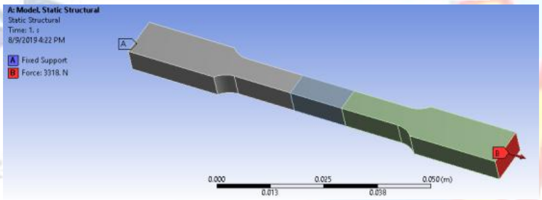
Results

Object Name	Total Deformation	Directional Deformation	Equivalent Elastic Strain	Equivalent Stress	Strain Energy
State	Solved				
Results					
Minimum	0. m	-1.3848e-004 m	1.9682e-004 m/m	1.3167e+007 Pa	3.7122e-005 J
Maximum	1.3849e-004 m	0. m	2.2274e-003 m/m	1.5388e+008 Pa	2.8015e-004 J



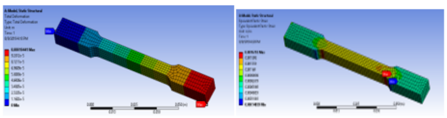






Results

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Strain Energy*
State	Solved				
Results					
Minimum	0. m	-1.044e-004 m	1.4839e-004 m/m	9.9268e+006 Pa	2.11e-005 J
Maximum	1.0441e-004 m	0. m	1.6793e-003 m/m	1.1601e+008 Pa	1.5924e-004 J



Impact test:

Mesh

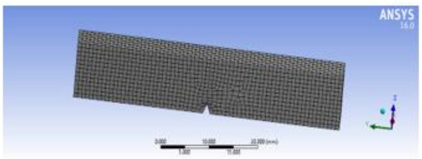
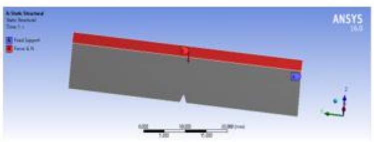


TABLE 5

Mesh

Object Name	*Mesh*
Statistics	
Nodes	32966
Elements	7032

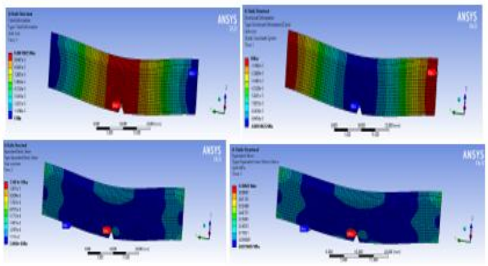


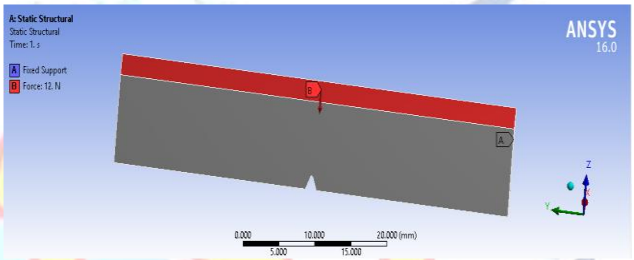
Loads

Object Name	*Fixed Support*	*Force*
Magnitude		6. N (ramped)
Direction		Defined

Results

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Strain Energy*
State	Solved				
Results					
Minimum	0. mm	-1.0622e-004 mm	2.6968e-008 mm/mm	1.9687e-003 MPa	4.8442e-010 mJ
Maximum	1.0625e-004 mm	0. mm	1.1601e-005 mm/mm	0.78605 MPa	3.0386e-007 mJ



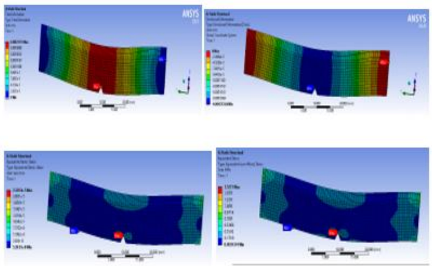


Loads

Object Name	*Fixed Support*	*Force*
Magnitude		12. N (ramped)

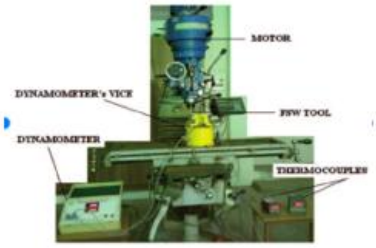
Results

Object Name	*Total Deformation*	*Directional Deformation*	*Equivalent Elastic Strain*	*Equivalent Stress*	*Strain Energy*
State	Solved				
Results					
Minimum	0. mm	-2.1244e-004 mm	5.3937e-008 mm/mm	3.9374e-003 MPa	1.9377e-009 mJ
Maximum	2.1251e-004 mm	0. mm	2.3203e-005 mm/mm	1.5721 MPa	1.2155e-006 mJ

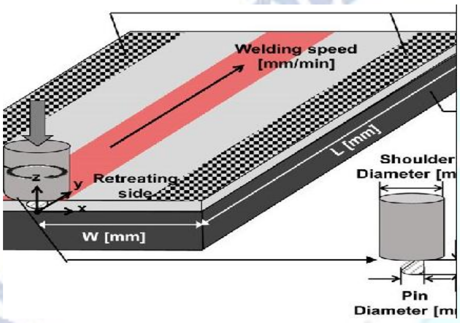


4. PROCEDURE FOR THE EXPERIMENT:

Friction steer welding (FSW) is a new type of welding technique that has evolved from classic welding and offers advantages over solid-state welding. This joining method has been shown to work with aluminum alloys, magnesium, copper and other low melting point metals. The beneficial turning tool is inserted into the butt edges of the sheets or plates and moved along the joint line 1,2 as shown in Fig. 1 - the turning tool containing the pin profile and shoulder causes friction. Causes significant plastic deformation of the material at hot and high temperatures, resulting in excellent weld quality and fine microstructure, as well as improved mechanical properties.



FSW's experimental setup. Friction Stir Welding (FSW)



The following are experiments conducted to study the mechanical properties of LM6-Titanium-Boron (LM6-Ti-B) metal matrix alloys.

TENSILE TEST NO. 4.1

The fracture sequence is shown in Figure 1. Has a great effect on the welding parameter 10. As found, FSW1 and FSW3 broke on the reverse side. Because combinations of lateral and rotational speeds are not compatible with these specific models, they can lead to cracks on the reverse side.

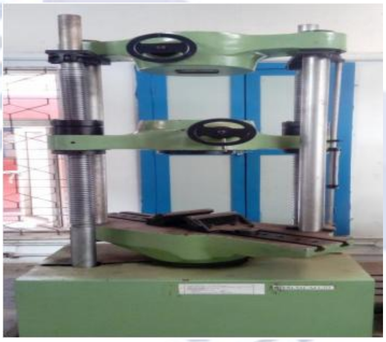
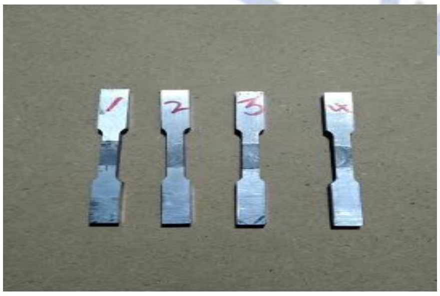
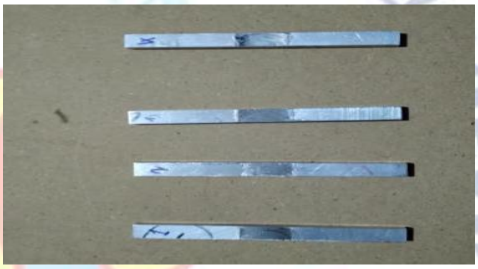
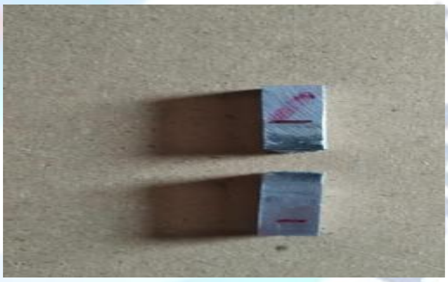


Figure 2 shows a universal testing machine.



Testing for impact





Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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