PERCUSSION AND TENSILE PROPERTIES OF SINGLE AND DOUBLE PASSED FSW ON AA6082 IN AIR & WATER

CHIKATI SATHEESH KUMAR
M.TECH STUDENT, DEPT of Mechanical
MIST COLLEGE SATHUPALLY
E-Mail: sateesh.311@gmail.com

B.BALOJI
Assistant Professor, DEPT of Mechanical
MIST College, Sathupally,
E-Mail: baloji3064@gmail.com

ABSTRACT

Welding is a process of joining similar and dissimilar metals by application of heat and pressure. Welding process is used commonly to join the missals like mild steel, aluminum, copper, magnesium, etc. In this experimental work proposed to conduct with FSW technique on dissimilar Al plates (AA6082), the process is carried out with double sided friction stir welding. The post welds are observed under water and air. The percussion and tensile properties like tensile strength, Hardness, percentage of elongation are planned to study.

Keywords: *Friction stirs welding (FSW), underwater, percussion properties, tensile properties, AA6082.*

INTRODUCATION

Friction stir welding is the most important and innovative process in the field of similar or dissimilar metal joining. Friction stir welding tool, having an electro-mechanically or hydraulically auto adjusting pin. The tool is having a major advancement in design of having a control system that forms a closed-loop feedback system to control the pin. The tool can be used to weld plates of different thickness. The material flow was asymmetric about the weld centerline, the flow patterns on the advancing & retreating sides were different. Two tool motions, translation and rotation are responsible for the movement of material in a FSW weld. There is no major influence of welding speed ranges of 700 mm/min to 1400 mm/min on the mechanical and fatigue properties of the friction stir weld joints. The friction stir weld joints showed higher static and dynamic strength than MIG-pulse and TIG welds.

Friction Stir Welding (FSW) is a thermo-mechanical Process in which two metals are joined together in the solid state, to produce a high strength, high quality joint. Compared with conventional arc welding processes, there are a number of benefits including; low distortion, minimal chemical segregation and, enhanced hardness and strength due to grain refinement in the stir zone. Although the process has reached a stage of technical maturity for the "light alloys", its application to metals such as steel, nickel and Titanium has been slower to develop due to the severe loads and temperatures the tool experiences during the welding process. Tool design and development of advanced materials for FSW of steel has therefore become a significant area of research in recent years, focusing specifically on improving tool lifespan. Investigated friction stir welding of industrial steels using two different tool materials.

The best mechanical properties like tensile strength and fatigue strength are achieved for the weld joints by increasing tool feed rate along with increasing the vertical force. The analysis of results concerning the contact conditions provides interesting data about the evolution of the relative sliding between the shoulder and the material to be welded. The sliding ratio increases with the tool rotational velocity and decreases with the temperature in the vicinity of the tool.

LITERATURE REVIEW:

(K. Elangovan et al. 2009) Compared FSW to the fusion attachment processes that area unit habitually used for connexion structural Al alloys. The attachment parameters like tool motion speed, attachment speed, axial force etc., and power pin profile is found to play a significant role choose the joint strength. a shot had been created to develop a mathematical model to predict lastingness of the friction stir welded AA6061aluminium alloy by incorporating FSW method parameters. Response surface technique (RSM) had been accustomed develop the model. applied math tools like analysis of variance (ANOVA), student's t-test, correlation co-efficient etc. had been accustomed validate the developed model.

(R. Palanivel et al. 2012) used FSW to affix half-dozen millimeter thick dissimilar Al alloys AA5083-H111 and AA6351-T6 and studied the impact of tool motion speed and pin profile on the microstructure and lastingness of the joints. Dissimilar joints were created mistreatment 3 completely different tool motion speeds of 600 revolutions per minute, 950 revolutions per minute and 1300 revolutions per minute and 5 completely different tool pin profiles of straight sq. (SS), straight polygon (SH), straight polygonal shape (SO), tapered sq. (TS), and tapered polygonal shape (TO). The tool motion speed and pin profile significantly influenced the microstructure and lastingness of the joints. The joint that was fancied mistreatment tool motion speed of 950 revolutions per minute and straight sq. pin profile yielded highest lastingness of 273 Mpa.

(K. Krasnowski et al. 2014) investigated the influence of tool form and weld configuration on the microstructure and mechanical properties of Al 6082 alloy FSW joints. 3 varieties of tool with completely different probe shapes and shoulder surfaces and 2 weld configurations (one sided and two-sided) were utilized in experiments. It showed that each one tool varieties turn out prime quality butt joints free

From defects or imperfections. the simplest lastingness was obtained by a traditional and triflute tool. The joint configuration influenced mechanical properties, the 2 sided welds exhibited lower mechanical properties attributable to larger heat transference into the fabric throughout the second pass. but the optimum method conditions haven't been evolved.

(AtulSuri et al. 2014) developed improved flat pin tool with aspect radius and compare it with customary straight rib pin tool with flat collar product of hardened steel. The impact of FSW was studied on hardness, strength, toughness and microstructure with completely different tool motion speeds starting from four hundred revolutions per minute to 1400 revolutions per minute, at a relentless feed rate i.e., at thirty mm/min for creating comparison between the freshly developed flat pin tool and therefore the customary straight rib pin tool. The comparative study indicated that, the freshly developed tool produces the higher lastingness than the quality straight rib tool within the entire vary of the tool motion speeds. the most strength of the FSW joints was seventy eight of that of its base metal at 400rpm mistreatment the new tool. it absolutely was more determined that, for each the tools, the hardness of weld zone is augmented at lower tool motion speed, whereas refined microstructure are often noticed on surface of the weld zone at higher tool motion speed.

FRICTION STIR WELDING PROCESS:

In Friction stir attachment method a conelike &Triangle tool with a shoulder, and a profiled pin, is slowly plunged into the connected edges of the bolt clamped work items and so translated on the length of the connected edges. The tool serves 3 primary functions, that is, heating of the work piece, movement of fabric to supply the joint, and containment the new metal below the tool shoulder. The rotating and traversing tool develops resistance heat that softens the encircling work piece material and permits the tool to maneuver on the joint line. The axial load and therefore the traversing motion of the tool cause the plasticized material to be due the front to the rear of the tool. once the tool moves forward, the transported material cools down and consolidates to make a joint in solid-state at temperature below the temperature of base metals.

The FSW method includes 3 phenomena: heating, plastic deformation, and formation. A non-consumable rotating tool, consisting of a groundwork and shoulder, is plunged into the materials to be joined and so traverses the joint line. Heat is generated through each friction and plastic deformation of the welded material. At elevated temperatures, the fabric plasticizes and is sheared at the front of the probe and it's turned to the rear of the probe wherever it's solid along beneath vital shoulder pressure. The FSW method is illustrated in Fig:1. The advancing facet is that the region during which the traverse rate and therefore the tangential rate of the rotating tool square measure within the same direction.

Fig 4: Friction stir welding process

The retreating side is the region in which the traverse velocity and the tangential velocity of the rotating tool are in opposite directions. This advancing or retreating phenomenon leads to different mixing characteristics within the weld seam, depending on location. These characteristics will be discussed further in the material flow section of the introduction. FSW can be performed on a variety of joint configurations, including butt joints, lap joints, and T-joints

Fig 5: Singlepass with conical tool

Fig6: Singlepass with triangle tool

Fig 7: Doublepass with conical tool

Fig 8:Doublepass with triangle

The four visually distinct micro structural zones shown below in Fig:9 in which welds in aluminum are typically divided into:

- Unaffected parent material,
- Heat affected zone,
- Thermo-mechanically affected zone, and
- Weld nugget.

Fig 9: Welding zone

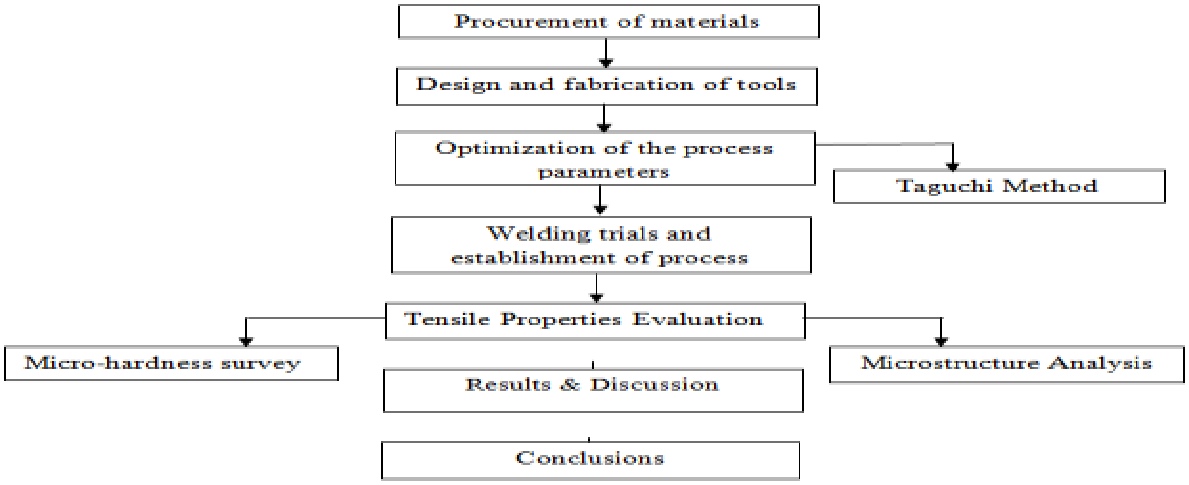
In the heat affected zone, properties and microstructure are affected by the heat from the weld, although there is no mechanical deformation. This zone

Retains the same grain structure as the parent materials. The thermo-mechanically affected zone shows characteristics that suggest that it underwent plastic deformation but recrystallization did not occur in this zone due to insufficient deformation strain. In weld nugget zone, intense plastic deformation and frictional heating during FSW result in recrystallized fine-grained microstructure. However, its use has become widespread, and as there is no word, which is equally simple with greater scientific merit, this term has been adopted. It has been suggested that the area immediately below the tool shoulder (which is clearly part of the TMAZ) should be given a separate category, as the grain structure is often different here. The microstructure here is determined by rubbing by the rear face of the shoulder, and the material may have cooled below its maximum. It is suggested that this area is treated

As a separate sub-zone of the TMAZ.

METHODOLOGY:

This chapter discusses the methodology adopted for achieving the desired objectives through experimental work. All other details like friction stir machine used, tool used, the base material, plates preparation, welding procedure adopted, procedure used for specimens preparation for testing, testing equipment's and recording of the responses etc. It is discussed under relevant headings as mentioned in the following sections. The trial experiments were conducted using Friction Stir Welding (FSW) on commercial AA6082-T6. Flow chart of experimental activities is described in Figure.



PROCESS PARAMETERS OF FSW:

The FSW parameters, toolgeometry and designof the joints are significant parameters, which have an effect on the material flow pattern and temperature distribution, thereby influencing the micro structural evolution of the material. The various process parameter of friction stir welding are listed below,

- Tool rotational speed (rpm)
- Tool traverse sped or welding speed (mm/min)
- Tool Feed in(mm/min)
- Tool design

  A. Pin length, L (mm)

  B. Tool shoulder diameter, D (mm)

  C. Pin diameter, d (mm)

  D. Ratio between shoulder and pin diameters

EXPERIMENTAL WORK AND ANALYSIS:

The flat plates of 5 mm thickness, AA6082 aluminum alloy, have been cut into the required size (150mm×75mm×5mm) by power hacksaw cutting and milling. Square butt joint was formed by FSW in a single pass welding procedure. No special treatment was carried out before welding and testing. Non-consumable tools made of stainless steel SS316 have been used to fabricate the joints and the chemical composition of tool material (SS316) and Work piece material was analyzed by energy dispersive X-ray spectroscopy.

Fig 10: Working process

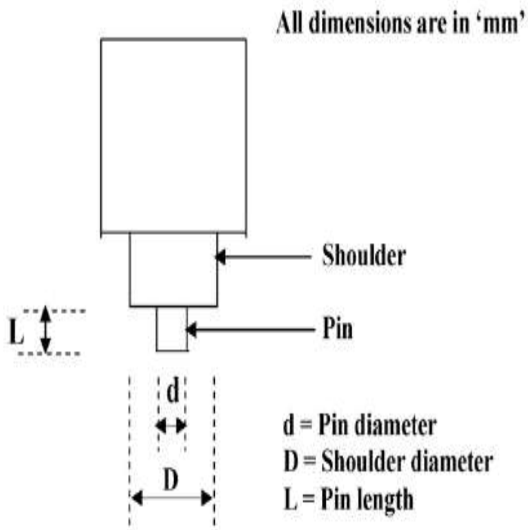


Fig11: Tool details

Tensile Strength (TS) or ultimate strength is the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross-section starts to significantly contract. The Tensile strength of the specimen is evaluated using a UTM machine shown in Figure5 the quality characteristic of Tensile strength is „Bigger the Better".

TENSILE STRENGTH:

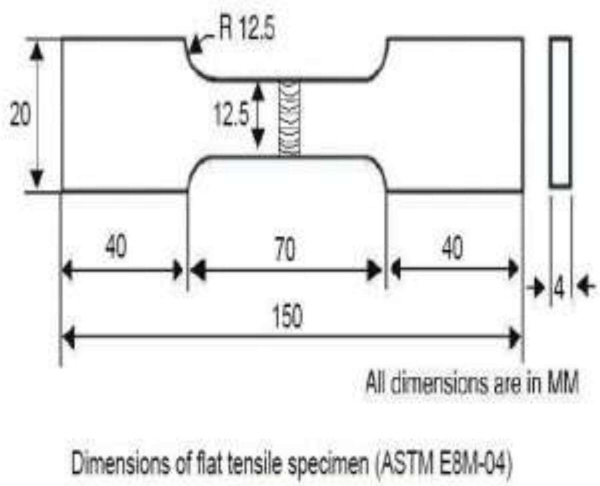


Fig 13: Tensile test specimen

Fig 14:Universal Testing Machine

Fig 15: Fractured specimens before tensile test

Fig 16: Fractured specimens after tensile test

TENSILE STRENGTH TEST (TRIANGLE) TOOL:

Speed in (rpm)	Traverse Speed in (mm/min)	Feed in (mm/min)	Air in (N/mm^2)	Water in (N/mm^2)	Single pass in (N/mm^2)	Double pass in (N/mm^2)
900	45	15	117.00	105.00	117.00	105.00
900	45	16	138.01	126.37	138.01	126.37
900	45	20	159.37	148.00	159.37	148.00
900	45	25	148.30	135.03	135.03	148.30

TENSILE STRENGTH TEST (CONICAL) TOOL:

Speed in (rpm)	Traverse Speed in (mm/min)	Feed in (mm/min)	Air in (N/mm^2)	Water in (N/mm^2)	Single pass in (N/mm^2)	Double pass in (N/mm^2)
900	45	15	117.24	105.00	117.24	105.00
900	45	16	138.01	117.24	138.01	117.24
900	45	20	159.37	148.00	159.37	148.00
900	45	25	148.30	135.03	148.30	135.03

Fig 17:Vickers hardness test machine

Micro hardness of the welds was measured with the test load of 200g. The indentations were made at midsection of the thickness of the plates across the joint. The micro hardness values were measured on Vickers micro hardness tester as shown in the Fig 18.

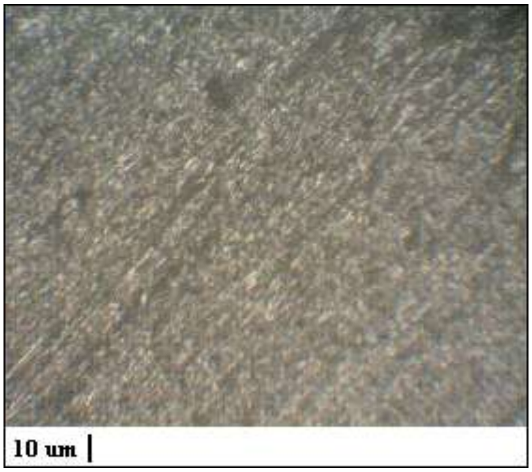


Fig 19: Single pass with conical tool

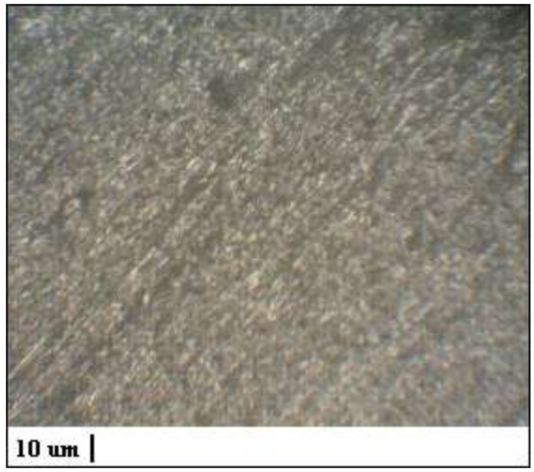


Fig 20: Single pass with triangle tool

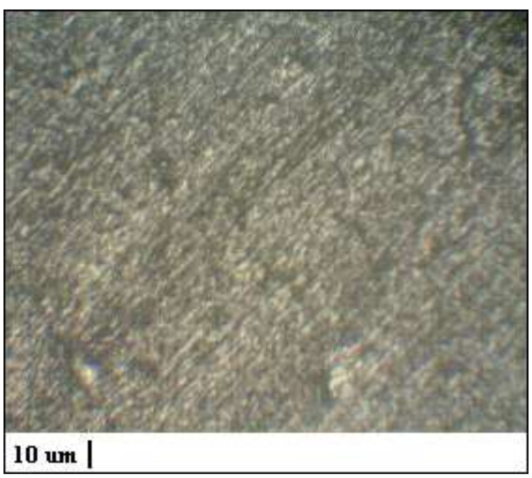


Fig 21: Double pass with conical tool

Fig 22: Double pass with triangle

CONCLUSION:

The solid-state nature of the FSW method, combined with its uncommon tool and uneven nature, ends up in a extremely characteristic microstructure. The microstructure may be uneven into the subsequent zones:

- The stir zone (also lump, dynamically recrystallised zone) may be a region of heavily distorted material that roughly corresponds to the placement of the pin throughout fastening. The grains within the stir zone ar roughly equiaxed and sometimes associate order of magnitude smaller than the grains within the parent material. a novel feature of the stir zone is that the common incidence of many concentric rings that has been remarked as associate "onion-ring" structure. The precise origin of those rings has not been firmly established, though variations in particle variety density, grain size and texture have all been instructed.

- The flow arm zone is on the side of the weld and consists of fabric that's dragged by the shoulder from the retiring aspect of the weld, round the rear of the tool, and deposited on the advancing aspect.

- The thermo-mechanically affected zone (TMAZ) happens on either aspect of the stir zone. during this region the strain and temperature ar lower and also the impact of fastening on the microstructure is correspondingly smaller. not like the stir zone the microstructure is recognizably that of the parent material, albeit considerably distorted and turned. though the term TMAZ technically refers to the complete distorted region it's usually wont to describe any region not already lined by the terms stir zone and flow arm.

- The heat-affected zone (HAZ) is common to all or any fastening processes. As indicated by the name, this region is subjected to a thermal cycle however isn't distorted throughout fastening. The temperatures ar less than those within the TMAZ however should still have a big impact if the microstructure is thermally unstable. In fact, in age-hardened metal alloys this region ordinarily exhibits the poorest mechanical properties