EFFECT OF ROTATIONAL SPEED ON TENSILE STRENGTH & MICRO HARDNESS OF FRICTION STIR WELDED AL2014 & AL5083- ALUMINIUM ALLOY

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ABSTRACT

Friction Stir Welding (FSW) is a solid state welding process to join materials by generating frictional heat between a rotating tool and materials being welded. It was invented at The Welding Institute (TWI), Cambridge (U.K.) in 1991. Since then FSW has become a major joining process in the aerospace, railway and ship building industries especially in the fabrication of aluminum alloys. It is difficult to weld the aluminum alloys, using arc welding, gas welding and other welding processes. Friction Stir Welding on the other hand, can be used to join most Al alloys and better surface finish is achieved. Although the work piece does heat up during friction stir weld, the temperature does not reach the melting point. In this research work, rotational speed is considered for experimentation to weld Al alloy AL2014 & AL5083 and their effect on mechanical properties such as tensile strength, and micro hardness of Heat Affected Zone, Thermo Mechanical Affected Zone and weldament. The influence of welding parameters has been presented in graphical form for better understanding. With the increase in tool rotational speed, coarse grain structure is produced, which resulted in low ultimate tensile strength and low impact strength. On the other hand high welding speed results in low heat input which improves the cooling rate, leaving a fine grained structure. This in turn increases ultimate strength and increases impact strength. With the increase in rotational speed, rate of heat input increases, which results in coarse microstructure, which in turn decreases the hardness. But at the same time increase in welding speed lowers the rate of heat input results in higher cooling rate and fine microstructure. Fine microstructure results in increased hardness.

Keywords*: *Strength And Micro Friction Stir Welding, AL2014 & AL5083 , Tensile Hardness

I INTRODUCTION

Modern aerospace concepts demand reductions in both the weight as well as cost of production of materials. Under such conditions, welding processes have proven most attractive, and programs have been set up to study their potential. This process is being used in wide variety of applications in the automotive, aerospace, ship building, and railroad industries. In FSW the interaction of a non-consumable and rotating tool with the work pieces being welded, creates a welded joint through frictional heating and plastic deformation at temperatures below the melting temperature of the alloys being joined. Based on friction heating at the contacting surfaces of two sheets to be joined, a special tool with a properly designed rotating probe travels down the length of contacting metal plates, producing a highly plastically deformed zone through the associated stirring action. The friction stir welding tool is the most significant component of the system and is designed for a specific type of weld joint. The tool used is in the shape of a cylindrical rod with a threaded pin, coaxial with the axis of rotation. It has main two parts shoulder and pin. Tools are manufactured from high wear resistant materials with good static and dynamic properties at welding temperatures. The strength and wear resistance of the tool must be superior to the base metal used in welding. Length of pin is slightly less than the weld depth required and tool shoulder should be in intimate contact with the work piece surface. Single pass of tool is used in friction welding process.

Element	% in AL2014	% in AL5083
Si	0.867	0.110
Mg	0.570	4.610
Cu	4.465	0.038
Mn	0.710	0.547
Zn	0.085	0.029
Fe	0.154	0.275
Pb	0.000	0.027
Bi	0.037	0.040
Cr	0.019	0.072
Ti	0.050	0.028
Sn	0.020	0.012
Al	92.950	94.150

Table.1: Chemical Composition

A composition of aluminium is shows in table 1. Fixture is used to hold the sample plates which are welded by FSW process on the bed of Universal CNC Milling Machine. Sample plates have to be clamped because these plates are to undergo high mechanical forces during the process. Special types of fixtures are designed as per requirements.

II PREPARATION OF SAMPLE

The plates were prepared with wn200*145*6 mm dimensions. Before the friction welding, the weld surface of the base material was cleaned. Plate edges to be weld were also prepared so that they are fully parallel to each other. This is to ensure that there is no bumpy gap between the plates which may not result in sound welding. Secondly surface preparation was also done so that the surfaces of both the plates are of equal level and footing.

In this work, the performance of FSW tools with straight cylindrical. The length of probe/pin of tools is slightly less than thickness of plates and diameter of pin is slightly greater than thickness of plates. In this work, there are four rotational speeds (1100, 1200, 1300 & 1400 in rpm).

A CNC universal milling machine was used to carry out the FSW experiments. The tool was mounted on the vertical spindle. Then two equipped aluminium pieces were clamped into the fixture. Then the rotating tool was made to insert into the butt joint. Then after some time, when there was adequate heating was achieved due to friction between tool and plates, the bed was given automatic feed, along the joint direction. Thus the welding was achieved. After that the pieces were cut into the samples of mandatory dimensions for performing the tensile test and micro hardness test.

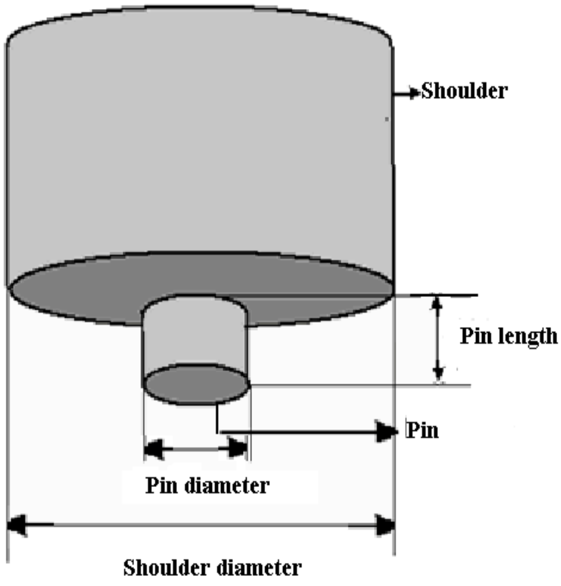
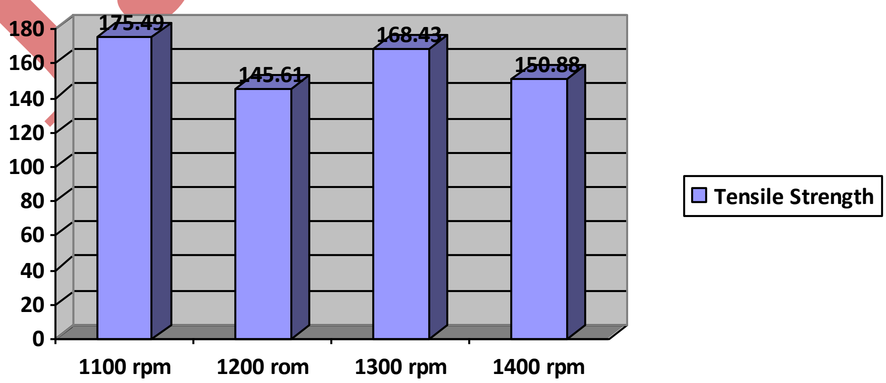


Fig 1: Tool Geometry

III RESULTS

3.1 Tensile Strength

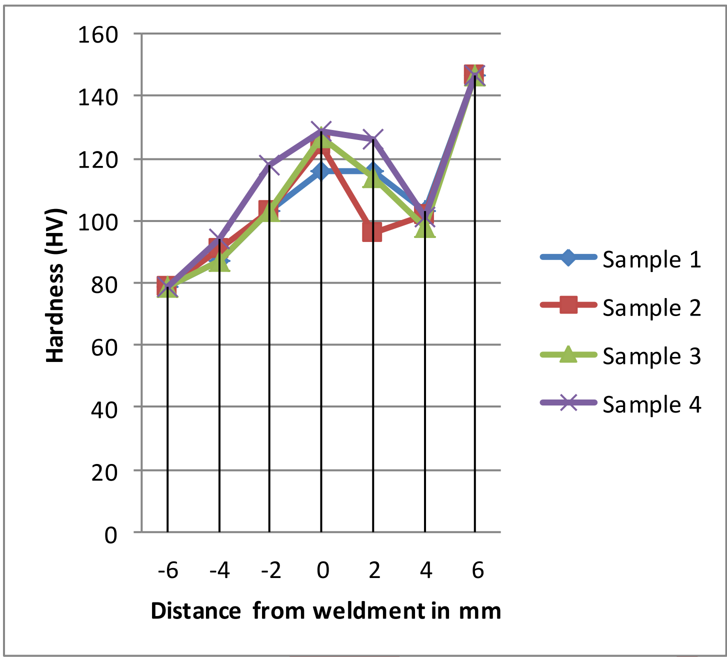
Tensile strength (in MPa) of samples is shown in following graph.1:



Graph.1: Variation of Tensile Strength

3.2 Micro Hardness

Micro Hardness of samples is shown in following graph .2



Graph.2: Variation of Impact Strength

IV CONCLUSIONS

Following are the conclusions for the study:-

Sample 1 has highest tensile strength i.e. 175.9 N/mm^2 and second lowest Vickers hardness i.e. 124. Sample 2 has lowest tensile strength i.e. 145.61 N/mm^2 and lowest Vickers hardness i.e. 116. Sample 3 has second highest tensile strength i.e. 168.43 N/mm^2 and second highest Vickers hardness i.e. 127. Sample 4 has second lowest tensile strength i.e. 150.83 N/mm^2 and highest Vickers hardness i.e. 129. Sample 2 has lowest hardness and lowest tensile strength as compared to other samples. Sample 4 has highest hardness and lowest tensile strength than other samples because microstructure shows that finer grains as compared to other samples.

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