Experimental Study On AA7075 Its Effect Of Rotational Speed And Tool Pin Profile On Friction Stir Welding Process

L. Srinivas Naik[1], Dr. B. Hadya[2] & Dr. Kolli Murahari[3]
[1]Mechanical Engineering Department, Anurag Group Of Institutions, Telangana, India
[2]Mechanical Engineering Department, Osmania University, Telangana, India
[3]Mechanical Engineering Department, KL University, Guntur, Andhra Pradesh, India

Abstract: **Welding parameters like welding speed, rotation speed, plunge depth, shoulder diameter etc., influence the weld zone properties, microstructure of friction stir welds, and formation behavior of welded sheets in a synergistic fashion. The main aims of the present work are to analyze the effect of welding speed, rotation speed, plunge depth, pin profile and shoulder diameter on the formation of internal defects during friction stir welding (FSW), optimize thee welding parameters for producing internal defect-free welds, and propose and validate a simple criterion to identify defect-free weld formation. The base material used for FSW throughout tht e work is Al 7075 T6 having a thickness value of 5 mm. Only butt welding of sheets is aimed in the present work. It is observed that present analysis that higher welding speed, higher rotation speed, and higher plunge depth are preferred for producing a weld without internal defects.**
Key words: Parameters, welding Speed, Rotation Speed, Shoulder Diameter, Plunge Depth.

I INTRODUCTION

Now a days, researches have been focusing on developing fast and Eco friendly process in manufacturing and this includes Friction stir welding and Processing. Fsw is a solid state welding technique invented and patented by The welding institute (TWI) in 1991 for butt and lap joint of ferrous and non ferrous metals and plastics, FSW is a continuous process that involves plunging a process of a specially shaped rotating tool between the butting faces of the joint.The relative motion between the tool and the substrate generates frictional heat that creates a plasticized region around the immersed portion of the tool [1].

FSW process uses a non consumable rotating tool consisting of a pin extending below a shoulder that is forced into the adjacent mating edges of the work pieces as illustrated in figure 1 the heat in put, the forging action and the stirring action of the tool includes a plastic flow in the material, forming a solid weld. In the FSW process that the tool designs is critical in producing sound welding [2]. The basic and conventional design for a FSW tool is shown in figure 2. This consists of a threaded pin and shoulder. FSW tools follow the same basic trends in terms of their shapes and geometries. They are comprised of three generic features including a shoulder, a probe also known as a pin. Tool having ratio of shoulder diameter to pin diameter (D/d) is three has been chosen for this study because it is having good joining properties among various pin configurations.

Tool design, good tool can improve both quality of the weld and maximum possible welding speed. So it is desirable that the tool material is sufficient strong, and hard wearing at the welding temperature a long with good oxidation resistance and low thermal conductivity, higher melting point materials. FSW process can be easily monitored and replicated in an addition; it does not produce any major safety hazardous, such as fume and radiation [3]. FSW has several advantages, such as low energy input, short welding time, low welding temperature, and relatively low distortion as compared to the conventional welding method [4]. Finding the most effective parameters on properties of FSW as well as realizing their influence o the weld properties has been major topics of inserts for researchers. The effect of important parameters such as axial force, rotational speed, and traverse speed on weld properties have been investigated [5].

In FSW, the process parameter have to determined separately for each new component and alloy the welding speed depends up non several factors, such as alloys type, rotational speed, penetration depth, and joint type. Aluminium alloys are potential candidates to replace non ferrous alloys in many structural applications owing t o some of their unique properties, aluminium alloys exhibit low density, high strength to weight ratio, and good actability. These alloys have attracted the interest of modern manufacturing such as the auto mobile, computer, communication, satellite, marine and consumer electronic applications industries. They are also considered as advanced materials in torms of energy conservation and environmental pollutions regulations, the joining of aluminium alloy parts, which may be crucial for the above applications [6]. Conventional fusion welding methods for joining aluminium alloys

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produce some defects such as porosity and hot crack, which deteriorate their mechanical properties. The production of the defect free weld requires complete elimination of the surface oxide layer and selection of suitable welding parameters. FSW is capable of joining aluminium alloys without melting and thus of it can eliminate problems related to solidification. FSW does not require any filler material, the metallurgical problems associated with it can also be eliminated and good quality weld can be obtained [7].In the FSW process, the tool geometry is the most influential aspect and plays a critical role in heat generation, material flow, required power, and micro structural evolution among various geometrical features of an FSW tool, the shoulder diameter, pin diameter and pin profile is very important for the reason that the shoulder and pin profile generates most o f the heat and prevents the plasticized material from escaping from the SZ[8].The influence of some of important parameters such as rotational speed, traverse speeds, number of FSP passes, axial tool pressure, tool tilt angle, tool shape and geometry[9]

AA 7075 is one of the most aluminum alloys, and it has been extensively used in automotive industries, the welding of AA7075 by fusion welding causes solidification cracking at the heat affected zone due to presence of aluminum alloy furthermore, oxidation and vaporization of zick during the welding revealed many defects such as porosity, lack of fusion, hazardous fumes, this alloys most prominent feathered is the high resistance to oxidation and corrosion thus, it has been extensively used in pressure vessel, tanks, trucks, and shipbuilding.[10] The process parameters should be well defined, regardless of the selected welding technique. In a process, the parameters that can be process parameters are not well defined, then many defects such as voids, distortion, solidification, cracking, and lack of penetration may occur. Especially in the case of the welding of dissimilar materials, thes defects may increased highlighted.[11] penetration depth.

In FSW, the effect of the process parameters on the micro structure, the material behavior and the mechanical features remains interesting. So, the simulations of FSW process under different passes parameters are performed to analyze the material behavior and the mechanical features to help the understanding of the mechanism of FSW and even to help the optimization of this joining technique in this paper. Experimental results under different process parameters are also given to improve the understanding of the effect of process parameters on joining parameters.FSW is a novel green manufacturing technique due to its energy efficiency and environmental friendliness. This solid state joining process and involves a rotating tool consisting of a shoulder and probe [12]

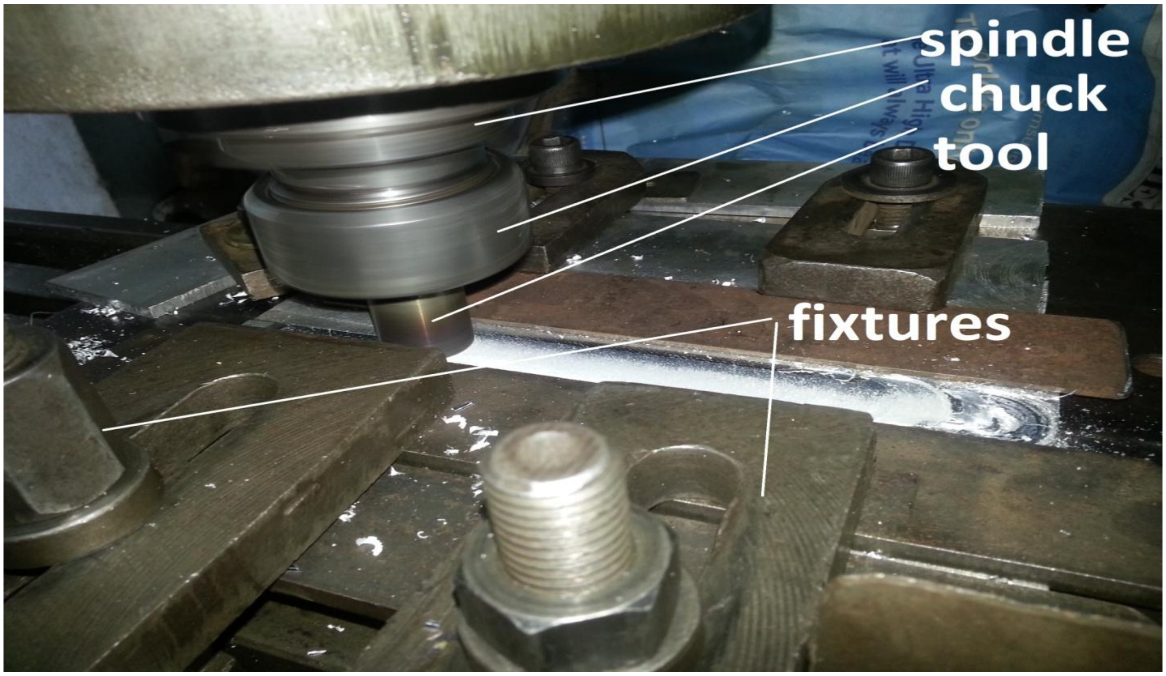

Figure1 Friction Stir Welding Setup

II METHODOLOGY

FLOW CHART OF METHODOLOGY:

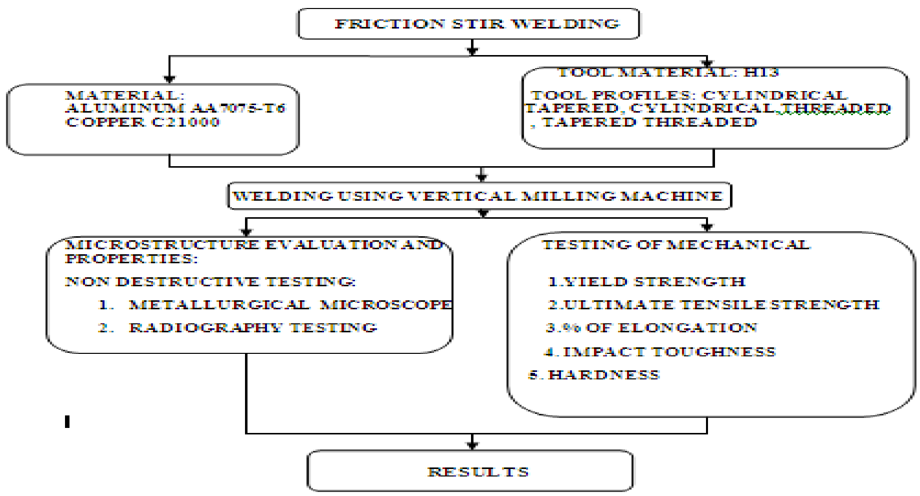

Table1 AA7075-T6 Chemical Composition

MATERIAL	Zn	Mg	Cu	Si, Fe, Ti, Cr
AA 7075-T6	5.6-6.1%	2.1-2.5%	1.2-1.6%	<0.5%

Table2 Mechanical Properties of AA7075-T6

Yield Strength	Ultimate Tensile Strength	% Of Elongation At Break	Fracture Toughness	Brinell Hardness	Young's Modulus	Poisson Ratio
503MPa	572MPa	11.0	25MPam$^{1/2}$	150	71.7GPa	0.33

Table3 Chemical of Composition H13 Tool Material.

MATERIAL	C	Cr	Fe	Mo	Si	V
ANSI H13	0.32-0.4	5.13-5.25	>=90.95	1.33-1.4	1	1

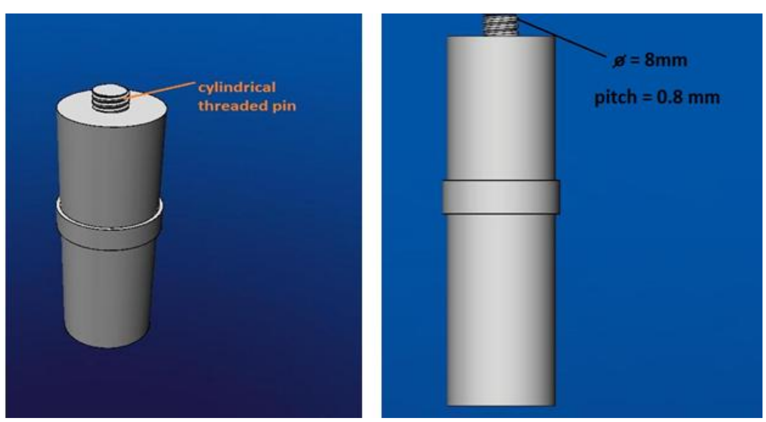

Figure2 Cylindrical threaded tool

Sheets of Al-alloys, Al 7075, 5 mm thick, 200 mm long and 75 mm wide were selected for but joint welding. Vertical milling machine of power rating 10hp with maximum spindle rotational speed of 2400 rmp manufactured by HMT used for welding Al-alloys, Chemical composition and Mechanical Properties of AA7075 as shown in table 1 and 2 respectively The tool used for this process was made of H13 quenched and tempered steel tool with a shoulder of 20mm diameter with a probe pin, 6mm probe diameter and 4.5 mm long. Shown in Figure.1 and was tilted by 1^0 to provide compressive force to the stirred weld zone. the shoulder diameter increases, the sticking torque, MT, increases, reaches a maximum and then decreases.H13 Chemical composition as shown in table3 First of all the plates which need to be welded are kept on the backing plate and they are rigidly fixed to the machine table with help of fixtures, because during welding the plates may get separated due to the force arising during welding. Initially a hole of 8mm diameter was drilled so that the plunging forces on the tool are get eliminated which are impact in nature and thereby increasing the life of tool. Then the welding tool is inserted in to the spindle of the machine and spindle is made to rotate at desired welding speed and the pin of welding tool is slowly inserted into the predrilled hole. And the tool is kept rotating in the predrilled hole for some time without giving feed, so that the sufficient amount of heat is generated due to friction between tool and material so that the temperature of joints is such that the plastic flow of the material is possible during forward motion of tool or during welding period. Then the feed is given to the tool and due to the plastic flow the material at the interface of the two plates the weld joint is formed. For all welding conditions the welding speed (feed of tool) is kept constant at 31.25mm/sec, because in this experiment we want to study the effect of tool profile and rotational speed on the properties of the friction stir welded joint we have to keep the welding speed (feed of tool) to be constant so that we can be able to study the effect of tool profile and rotational speed. At the end of welding, before pulling the tool out of the joint the feed is stopped and the tool is pulled out of the joint. Like this by changing the tool and rotational speed the welding was performed on the aluminum alloy plates. The Tool pin is then moved against the work piece, or vice- versa. Frictional heat is generated between the wear resistant welding tool shoulder and pin, and the material of the work-pieces. This heat, along with the heat generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without reaching the melting point (hence cited a solid-state process).As the pin is moved in the direction of welding the leading face of the pin, assisted by a special pin profile, forces plasticized material to the back of the pin whilst applying a substantial forging force to consolidate the weld metal as shown above Figure2.

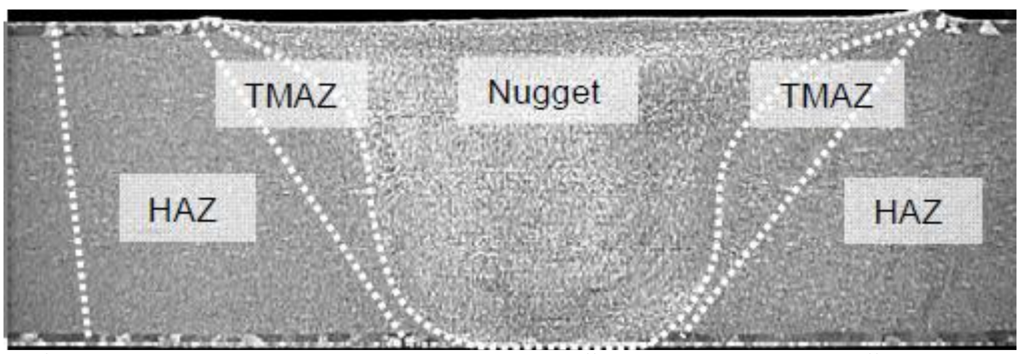

Figure3 Different type of zones in welded region – weld nugget, thermo mechanically affected zone (TMAZ), and heat affected zone (HAZ).

III RESULTS

A. Tensile Testing

The tensile tests were conducted to determine the tensile properties of similar aluminum alloy alloys of aluminum alloy 7075 friction stir weldments at rotational speed of the tool (900rpm) in a Universal Testing Machine (UTM) as per ASTM standards. Tensile strength of FSW welds is directly proportional to the travel welding speed as shown above Figure1. Hardness drop was observed in the weld region. That softening was most evident in the heat affected zone on the advancing side of the welds that corresponded to the failure location in tensile tests. An initial stage of a tunnel defect was found at the intersection of weld nugget and thermo-mechanically affected zone. The Ultimate Tensile Strength (N/mm2), The Yield Strength (N/mm2) and The Percentage Elongation of FSW aluminum alloy 7075 joints with Cylindrical threaded tool pin profiles. These FSW aluminum joints are prepared at constant tool rotation of 900 rpm and a constant tool forwarding speed of 31.25 mm/min. We can observe that Ultimate tensile Strength is maximum and it is same for both Cylindrical and Taper tools. But Yield Strengths of Cylindrical and Taper tools are lower than joint prepared by Cylindrical threaded tool. During preparation of aluminum butt joints the weld zone reached to the red hot condition. We can observe that Percentage Elongation is more for joint prepared by Cylindrical threaded tool gives an elongation of 26.98% during Tensile test. we can observe that Different type of zones in welded region weld nugget(NZ), thermo mechanically affected zone (TMAZ), and heat affected zone (HAZ) as shown in figure3.

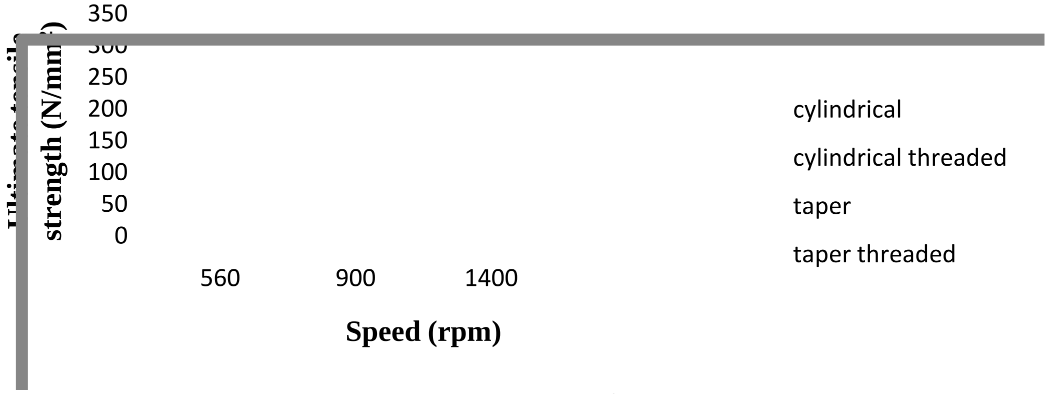

Figure4 Ultimate Tensile Strength of FSW AA7075 joints.

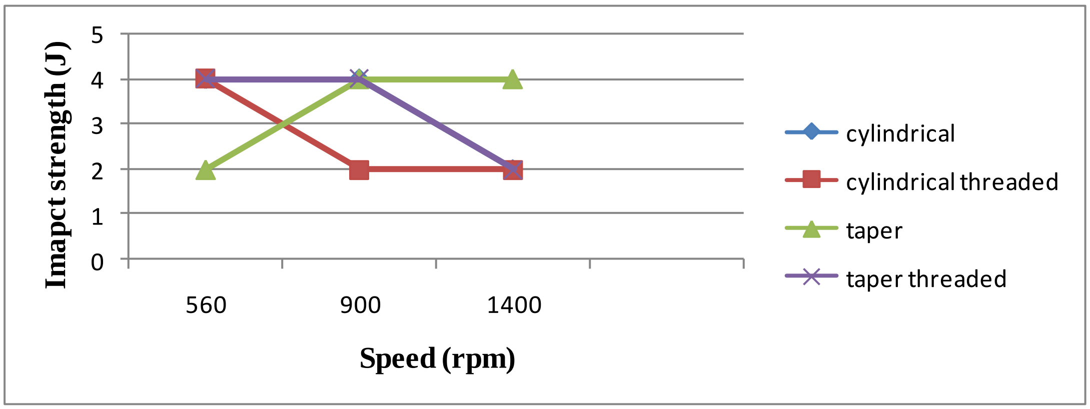

Figure 5 Impact Strength of FSW AA7075-T6 joints.

B. Hardness Testing

Rockwell hardness tests were performed to determine hardness of friction stir weldments of similar aluminum alloys7075 at rotational speed of the tool 900 rpm we can observe that hardness is 84 obtained with cylindrical tool at 900rpm.Hardness change in the welded material is affected from the amount of the heat input during the welding process. The hardness profiles were obtained at the middle portions of the weld zone. Less heat input in the FSW process lowers the area where hardness changes .Hardness observed in the weld center was higher than that in the thermo mechanically affected zone. However, hardness in all regions was less comparing with the base materials

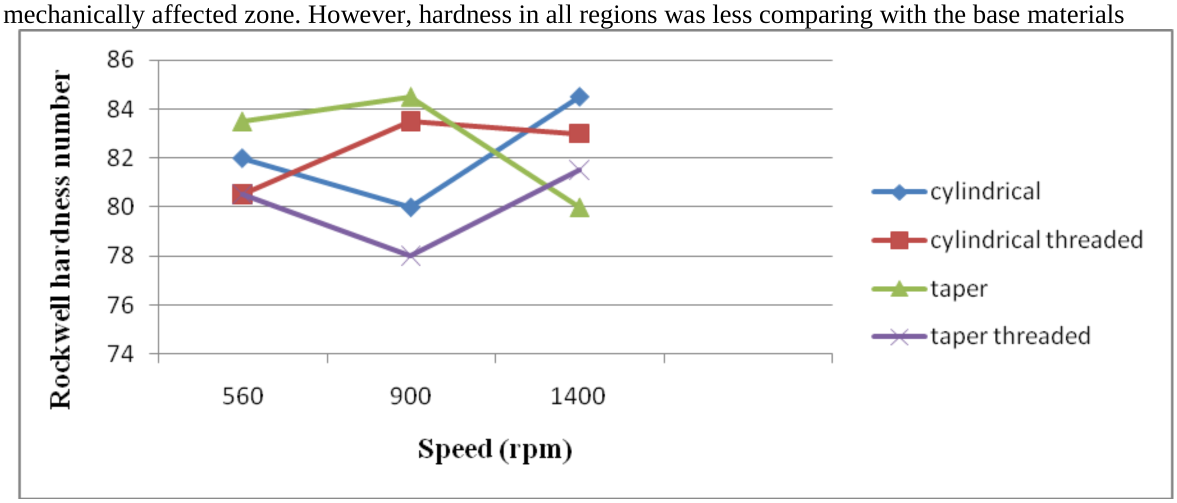

Figure 6Rockwell Hardness of FSW Aluminum 7075 joints.

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C. Impact Testing

The Charpy impact test was performed to determine the impact energy of similar aluminum alloys AA7075 friction stir weldments at rotational speed of the tool 900 rpm and tool feed speed of 31.25 mm/min. as per ASTM. Impact Strength is 2J. This low strength is due to the joint considered for the Impact test is taken at the beginning of the weld.

VI. CONCLUSION

The experimental investigations on friction stir welding of aluminum are performed to optimize the friction stir welding parameters. The welding was successfully performed using type of tool cylindrical threaded. And welding is performed at rotational speeds of tool such 900rpm. During welding the welding speed is kept constant for the purpose of comparison of the weld joint properties as the function of tool profile and rotational speed only. The maximum yield strength of aluminum occurred at welding condition of cylindrical threaded tool at 900rpm, because the thermal conductivity of aluminum is more the generated by cylindrical threaded is enough even though the heat generated

V. REFERENCES

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