FRICTION STIR WELDING USING RECONFRIGURABLE MANUFACTURING SYSTEM: A REVIEW

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Abstract— In this paper an attempt is made to review technique for modifying vertical milling machine to achieve friction stir welding (FSW) which is a solid-state joining process. Modifying a vertical milling machine by designing a attachment to weld two metals using the stir friction welding. Friction stir welding works upon the concept of heat generated due to the friction. It is considered to be a green process with no fumes or arc light emitted nor shielding gas or welding wire consumed.

Index Terms— reconfriguable manufacturing system, friction stir welding, solid-state welding, FSW paper review

1 INTRODUCTION

Solid state welding processes like forge welding, cold welding, explosive welding, friction welding are processes that produces weld at temperatures lower than the melting point of the materials being joined, without the addition use of filler metals and pressure may or may not be used. The solid phase welding, using which wide range of parts with various geometries can be welded using friction is called Friction Stir Welding (FSW). The friction stir welding was introduced by W.Thomas and his colleagues at The Welding Institute (TWI), UK, in 1991. Friction stir welding can be used for a wide range of application mainly in ship building, aerospace, automobile and also in other manufacturing industries.

Recently more focus is given to development of fast and efficient processes which are environment friendly. Friction stir welding is a relatively simple process that is environment friendly as it requires no external source as fuel to produce heat which is needed to weld the two materials together, nor does it leaves any residue at the end of the process. Friction stir welding process has been in the spotlight light for the past few years as a welding technology through which welds with negligible defects associated with fusion of material can be achieved.

Friction stir welding (FSW) is a recent upcoming technique that generates frictional heat without consuming metal but by rotation of a welding tool to obtain plastic deformation at the welding location, which results in the formation of a joint while the material is still in the solid state. Figure shows the schematic diagram of friction stir welding; it also represents the various parameters related to the process. A rotating tool which is pressed against the surface of the two plates to be welded together. The 'advancing side' is the side of the weld for which the rotation tool creating the weld move in the same direction as the traversing direction. The 'retreating side' or the other side is the side where the rotation of tool is in the opposite direction to the traversing direction.

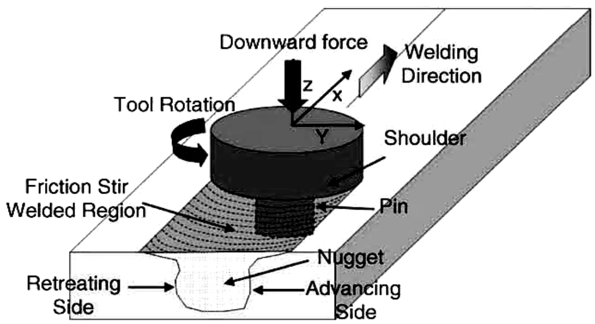
2 Literature review

"Utilization of engineering workshop equipment for friction stir welding" In this paper a Parkson Vertical milling machine was successfully able to provide friction stir weld on 6082-T6 aluminum sheets of various thickness ranging from 4.6mm to 6.3mm. The tool used in this process was manufactured by 19mm diameter silver steel. The pieces to be welded were held using bolts and backing plate fixed directly to the bed of the milling machine.

"Reconfiguration of a Milling Machine to achieve Friction Stir Welds" In this paper by Akinlabi Esther Titilayo, Madyira Daniel Makundwaney and Akinlabi Stephen Akinwale friction stir weld was achieved. A 600mmX120mmX3mm thick sheets of 6084-T6 aluminum alloy(AA) and C1000 copper(Cu) were welded using FSW also 600mmX220mmX3mm thick sheets of aluminum were welded using friction stir welding. The tool was made to rotate at various speeds of 600,900 and 1200 rpm with the feed rates of 50,150 and 250 mm/min. this three setting were used to represent low, medium and high setting. The tool was manufactured out of tool steel. The optimum joint strength of 74% was achieved.

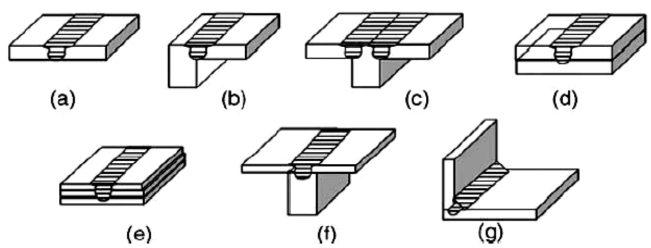
"Friction Stir Welding as a Joining Process through Modified Conventional Milling Machine" Is a review paper by Mohd. Anees Siddiqui, S.A.H. Jafri, P.K.Bharti and Promod Kumar where various techniques were reviewed and various tool designs used for friction stir welding were mentioned also the various type of joints that can be achieved used FSW were mentioned. The major part of the paper represented the information about the tool geometry and the parameters of the tool that affected the welding process. This paper also mentions the various field where FSW is begin used like aerospace, ship building and automotive industries.

"A DESIGN METHODOLOGY FOR RECONFIGURABLE MILLING MACHINE TOOLS AND AN IMPLEMENTATION" In this paper Hay Azulay focuses on the methodologies that can be used to reconfigure a milling machine and tools design that can allow various processes to be carried out on the milling machine. The paper explains the machine architecture. It also describes various RMT design methodologies and their framework. Also the steps to solve a problem using the reconfrigurable methodology are explained in this paper.



3 PROBLEM DEFINITION

Friction stir welding (FSW) is a process that joins two facing work pieces together without melting them or using a filler metal, the material stay in the solid-state during the entire process. Friction between the rotating tool and the work piece surface generates heat, this heat is responsible for softening of the material near the region of the tool. The purpose of this paper is to give a summary of the process and explain the terminology related to the process.



Variou weld using FSW

4 OBJECTIVES

The main objectives of the project is to design an attachment for the vertical milling machine, using which stir friction welding can be carried out. This process does not require consumable filler material, the heat generated due to friction fuses the edge of two materials together creating a quick weld.

5 METHODOLOGY

" Utilization of engineering workshop equipment for friction stir welding" in this paper T.Minton& D. J. Mynors successfully performed friction stir welding on a vertical milling machine. Two set of trials were undertaken. In the first set of trials starting at the maximum speed which was kept constant and the feed speed which was reduced until the welding stopped, thus obtaining the minimum feed speed. In the second set of trials the feed speed was kept constant and the spindle speed was reduced until the welding stopped, thus obtaining the minimum spindle speed. This paper provided the speed range with the respective feed rates for various thickness of the sheets of material to be welded.

"Reconfiguration of a Milling Machine to achieve Friction Stir Welding" . A model YS5BS vertical milling machine was reconfigured FSW on aluminium and copper in a butt joint configuration. A 4 KW motor milling machine with speed varying from 70 to 4200 rpm was used with a 5mm long threaded pin and 18mm concave shoulder tool made from H13 tool steel and hardened 52 HRC. A 600mmX120mmX3mm thick sheets of 6084-T6 aluminum alloy(AA) and C1000 copper(Cu) were welded using FSW also 600mmX220mmX3mm thick sheets of aluminum were welded using friction stir welding.

6 TOOL GEOMETRY

Tool geometry affects the heat generation rate, traverse force, torque and the thermo chemical environment experienced by the tool. The flow of plasticized material in the work piece is affected by the tool geometry affects the flow of plastic material in the work piece as well as the linear and rotational motion of the tool. Important factors such as shape, size, nature of tool surface and also other factors like shoulder diameter, shoulder surface angle, pin geometry also affect the whole process directly.

The diameter of the tool shoulder is one of the most important factor as it affects the heat generated on the material and also its grip on the plasticized materials helps in the material flow. The sliding and sticking process of the tool on the surface generate heat but the material flow is caused only by the sticking. To obtain a good FSW practice, adequately soften material for flow should be used, the tool with a proper grip on the plasticized material is needed and also the factor related to the tool such as total torque and traverse force should be under certain limits. It is seen that a tool with optimum shoulder diameter is capable of producing a strong weld. Optimizing shoulder diameter provide maximizing tool's grip on the plasticized material.

The tool shoulder surface is one of the most important aspect of tool design. The study of flat, convex and also concave tool shoulders, with the triangular pin geometries, cylindrical, tapered and inverse tapered showed that high strength spot welds was possible with triangular pins having concave shoulders. A convex shoulder with scrolls can be used to improve the friction stir welding process. It was observed that by using a convex scroll shoulder with constant axial force, any increase made in plunge depth resulted in greater contact area between the shoulder and the work piece. As results, the axial pressure were reduced and the plunge depth decreases to its original value. In the same way a decrease in plunge depth lowers the shoulder to workpiece contact area which results in a high axial pressure. Therefore, the FSW process with convex scroll shoulder is said to be more stable with a nearly constant plunge depth

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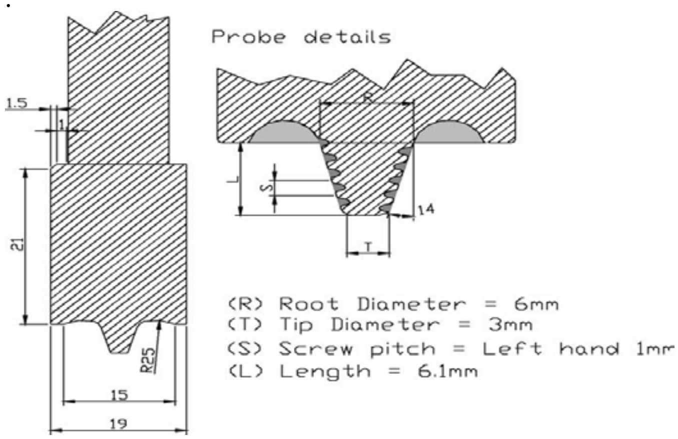

Tool used for 6.3mm sheet

7 SCOPE

Friction stir welding helps in manufacturing of aerospace components. The heat input during joining which is low, results in less residual stress, assuring precise welding of the components. This saves money and time as it is a fast process in comparison to other wildings processes. In larger road transport vehicles, the scope for applications is wider and easier to adapt – long, straight or curved welds: trailer beams, cabins and doors, spoilers, front walls, closed body or curtains, frames, rear doors and tail lifts, floors, sides, front and rear bumpers, chassis fuel and air containers, tool boxes, wheels, engine parts, etc.

8 CONCLUSION

The study of various papers on frictional stir welding show successful welding of two sheets of same or different material using non-consumable and a harder material designed to be attached to a vertical milling machine and producing heat as a result to friction between the tool and the surface of the materials and perform the welding in the solid-state. The various materials which can be welded using FSW and the materials used to manufacture the tools for them were discussed with the speed and also the feed rate.

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