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Friction Stir welding Application in Aerospace Engineering: A Review

Nasir Khan

Department of Mechanical Engineering, Amity School of Engineering and Technology, Amity University Madhya Pradesh, Maharajpura Dang, Gwalior, India 474005, nkhan@gwa.amity.edu

***Abstract*- Friction Stir Welding (FSW) is relatively new solid-state welding technique used to weld materials which otherwise difficult to weld by conventional methods. It has been used in aerospace, railway, construction and automobiles for making high-strength structures due to its added advantages of light weight, less distortion, and high mechanical properties. This study reviews the application of FSW to produce large capacity structure.**

***Keywords*-** Friction stir welding, aerospace industry, process parameters.

I. INTRODUCTION

Aluminum alloy is widely used for making structures for aerospace due to its low weight and high strength. Speed is the key feature need to consider while making the components for aerospace. The welding of aluminum is tedious when it is done by conventional method. The defects arise due to weld such as distortion gives rise to develop new technology for aluminum welding. Friction stir welding (FSW) is relatively new welding technique to weld aluminum alloys [1]. Friction stir welding was invented at The Welding Institute in 1991. The technique is derived from the conventional frictional welding. This process is suitable for component, which are flat and also suitable for pipes and hollow section. It has emerged as new solid state welding technique for aluminum alloys, magnesium alloys, titanium alloys and even for metal matrix composites. Today this technique is also used to join materials from plastic to high strength steels. The application of this technique is found in automobile, aircraft, shipbuilding and high speed trains. FSW is a continuous, mechanical and solid state joining technique uses a non-consumable and rotating cylindrical pin tool with a profile probe that rotates at high speed, and is then plunged into the butting edges of the joining material (Fig.1). The plates need to join first clamped on backing plate so that these could be prevented to move apart. Due to friction heat is generated between the tool and the material to be joined. It causes soften the material without reaching its melting point and permit the wear resistant tool to be traversed along the joint line. The length of the tool pin is slightly less than the thickness of the weld material and tool shoulder must be in contact with the welding material during welding. The unique feature of FSW over conventional welding is improved weldability. The FSW also increases the cosmetic appearance of the joint. It leads to lower residual stress and improved corrosion resistance. The application of FSW is found in aerospace, railways, shipbuilding, marine and construction. The demand for higher speed in the transport system leading to the lighter weight of the automobile, thus FSW is also popularizing in the automobile sector. The strength of the FSW joint depends upon various parameters i.e. welding speed, rotary speed, tool profile and tilt angle. Several researchers have worked to optimize mechanical properties by selecting parameters at a different level. The welding of soft alloys is difficult due to higher thermal conductivity, porosity and lack of inclusions. This leads to need for a method that could be used to weld such alloys. The selection of process parameters for getting defect free FSW joints is one of the important aspects. The only drawback of FSW is a requirement of special design fixture to hold the base plate and key hole at the end of the process.

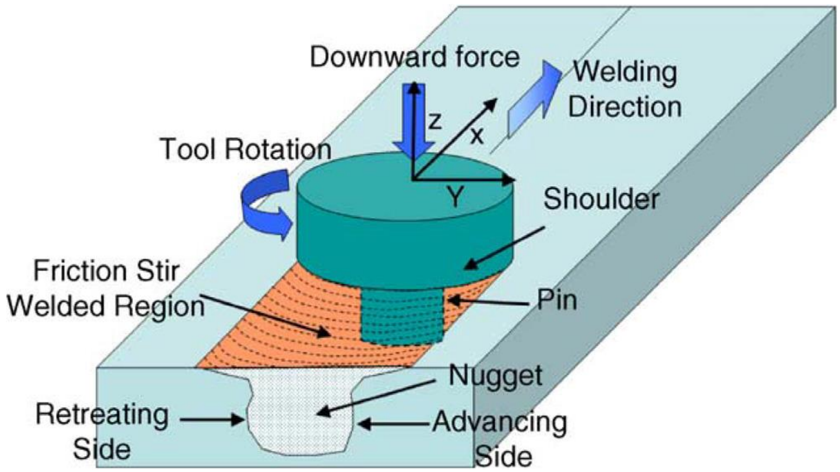

Fig. 1: Illustrative representation of FSW

The strength of the FSW joint depends upon parameters. Tool variables, machine variables and material variables need to control within the working limit to get sound welding of soft alloys. Tool variables include tool geometry, shoulder diameter, pin diameter and pin length. Machine variables include welding speed, rotation speed and tilt angle. Material variables are thermal and mechanical properties of base metal. FSW has wide applications in various fields. NASA is also using Friction stir welding for the launching vehicles. The application of FSW is also there in making of high speed train. The train manufacturer such as KHI, Hitachi, Nippon is making high speed train of aluminum alloys by using FSW. These trains cover long distances with short time due to its light weight. The automobile manufacturer such as Tesla, Mazda, Ford and Audi has adopted FSW for Vehicle construction [4-6]. The FSW technique is also used by Lockheed Martin, Airbus, Bombardier, Boeing, BAE systems and Embraer for making aircrafts. The advantage of using this technique to join components makes the structure light weighted [7-9]. Fig. 2 shows use of robotics in FSW. Apple Inc. also adopted FSW technique for building the device 40% thinner [11]. Thus, this technique is fulfilling the requirement of aeronautics industry due to it’s improve mechanical properties and corrosion resistance. There are some other future prospects of FSW need to be investigated and develop for extensive research.

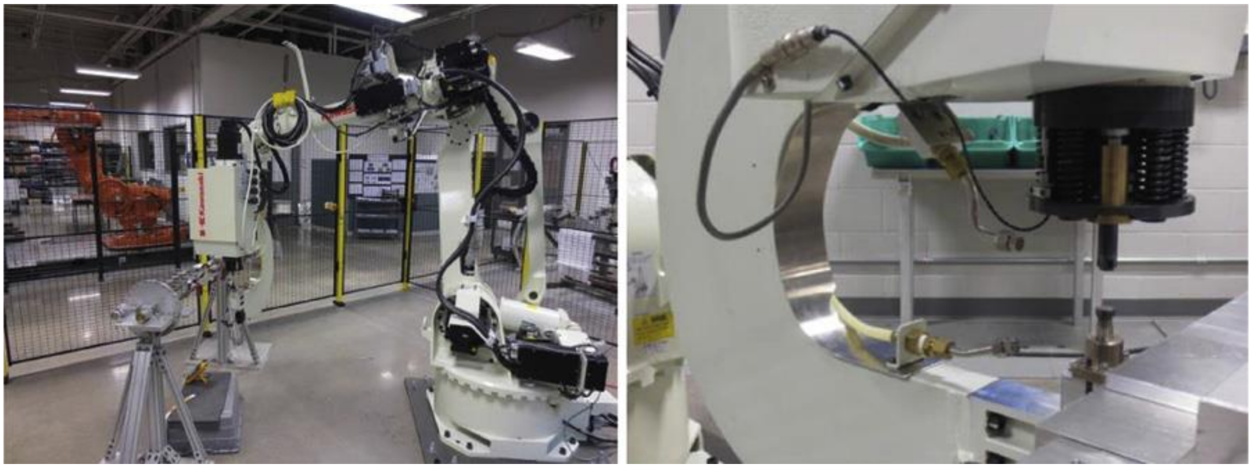

Fig. 2. Kawasaki Robot for FSW

II. CONCLUSION

This review paper point outs the application of Friction Stir Welding in the field of aerospace. However, some other method also invented by using an extended version of FSW to make big structures. This method has proven cost effective and alternate of other welding technique to weld materials that are difficult to weld by using conventional methods. This method has potential to weld other alloys i.e. titanium alloys which can be used to make more big structure with high strength.

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