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Review of State of Art of Friction Stir Welding

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Abstract: Friction stir welding is a solid state joining method of welding invented in 1991 at The Welding Institute that utilizes a non-consumable rotating welding tool to generate frictional heat and plastic deformation.FSW can be used to join difficult to join materials like aluminium alloys, copper, magnesium, zinc, steels, and titanium.This technique overcomes difficulties of fusion welding.FSW found applications in the automobile, aerospace, marine, defence and medical industries. The control parameters rotational speed, axial load, tool geometry, welds speed affects quality of weld obtained. The advantages of Friction stir welding (FSW) are no fumes; uses no filler material; and low cost of operation. FSW sometimes produces a weld that is stronger than the base material.FSW is considerably ecofriendly than conventional "fusion" welding. In this paper, review of state of art, working principle, welding of different materials, work piece material applications etc are presented.

Keywords: Solid State Joining.

I. INTRODUCTION

Friction Stir Welding (FSW) is a solid state joining process which overcomes many issues associated with traditional joining methods. The basic concept of friction stir welding is simple that creates extremely good quality and high strength joints with low distortion. A non consumable rotating tool with special probe and shoulder is inserted into abutting edges of workpiece.FSW produces welds of difficult to weld materials such as aluminium, and becoming the process of choice for manufacturing lightweight structures for automobiles, boats, trains, and aeroplanes. This joining method is energy efficient, ecofriendly, and versatile.FSW is found to be the most significant in metal joining in a decade. Recently, friction stir processing (FSP) was developed for surface modification of metallic materials. A non consumable rotating tool bit is inserted into a work piece. The interaction and rotation of the tool creates friction that produces heat which makes material into a plastic state. As the tool traverses the weld joint, it material flow extrudes in a distinctive flow pattern and forges the material. The solid phase bond obtained joins the two pieces into one.Fig.1.depicts principle of friction stir welding.

II. LITERATURE REVIEW

Ericsson et al (2002) investigated that the fatigue strength of friction stir weld. It is also find the fatigue result for conventional arc welding method. It has no major influence on the mechanical and fatigue properties of f s weld. It has increased amount of heat supplied to the weld per unit

Liu et al. (2003) in their research paper discussed the friction stir weld ability of the aluminium alloy and determine optimum welding parameters, the relations between welding parameters and tensile properties of the joints.

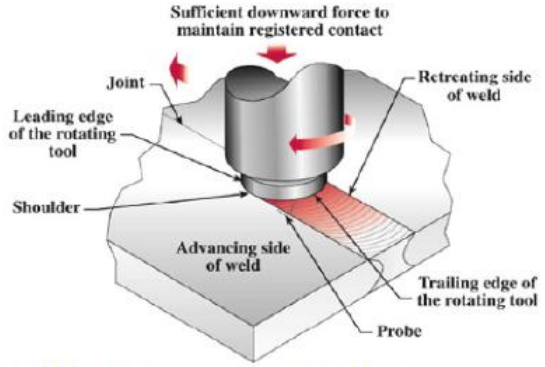

Figure1: Schematic drawing of working process principle of FSW

Researchers found that the tensile properties and fracture locations of the joints are significantly affected by the welding process parameters.

Kovacevic (2003) In their research friction stir welding (FSW) is a relatively new welding process that may have significant advantages compared to the fusion processes as follow: joining of conventionally non-fusion weld able alloys, reduced distortion and improved mechanical properties of weld able alloys joints due to the pure solid-state joining of metals.

Huseyin uzun et al (2004) these investigated that the joining of dissimilar Al alloy using friction stir welding. Hardness and fatigue property of friction stir welding similary checked

Cavaliere et al. (2005) investigate mechanical and micro structural properties of dissimilar aluminium joined by friction stir welding (FSW). The two sheets 2024 and 7075 sheets and joints which are aligned with perpendicular rolling directions and are in tension at room temperature and analyse their response with respect to parent material.

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kovacevic (2005) they studied and research thermo mechanical simulation of friction stir welding FSW can predict the transient temperature field, some active stresses are developed also forcing all three dimensional and may be extended to determine the residual stresses, thermal stresses are in major quantity, boundary conditions in the thermal modelling of process plays important role in final temoerature profile.

Driver a (2005) they present paper in which detail study of three dimensional thermo mechanical model for friction stir welding FSW they also present the heat input from tool shoulder and plastic strain of the bulk material. They studied the strain rates and various weld zone according to their micro hardness and the estimation of temperatures. The calculated results are in proportion with experimental performed on AA2024-T351 alloy FSW joint.

Marzol et. al.(2006) they establishes FSW technique for an AA6061 alloy reinforced with 20% Al2O3 particles and determine the properties of joints after deep study of FSW technique and the obstacles in the joining MMC'S experimental procedure is illustrated. The obtained microstructure are observed with a optical microscope and images are analysed with image analysis software also microhardness and tensile tests are carried out the tool stirring effect and shape are studied. Tensile testing revealed joint efficiencies over 80% for the RpO12, and slightly more than 70% for the Rm.

Watanbe et al. (2006) by using friction stir welding aluminium alloy plate to mild steel plate he did butt weld. Then he investigated the effects of pin rotation speed. The position of pin inserted is on the basis of tensile strength and microstructure of joint oxide film behaviour on frying surface of steel is examined. He got results such that butt welding of aluminium alloy plate to a steel plate is easily done by using FSW tensile strength is about 86% of that aluminium alloy base metal. Small amount of inter metallic compound was formed at the upper part of steel/aluminium interface. There know inter metallic compounds were observed in the middle and bottom parts.it seemed to fracture paths in joints.

Scialpi et al. (2006) they studied the effect of different shoulder geometries on the micro structural properties of the friction stir welded joints. they used T6 aluminium alloy having thickness 1.5 mm shoulder with scroll and fillet, cavity and fillet and only fillet are different from three studied tools the effect of three shoulder geometrical has been inspected by visual inspection, macrograph, HV microhardness, bending test and transverse and longitudinal room temperature, tensile test. Result showed that, thin sheets has been welded by shoulder with fillet and cavity.

Ceschini et. al. (2006) he enumerated that application of solid welding technique. In that particles seems very attractive. it should eliminate some defects during traditional fusion welding such as gas blockage, undesired chemical reaction between the two faces, non uniform reinforcement distribution after welding, he describes the effect of FSW process on microstructure

Zhang et al. (2007) he used finite element method on the. basis of solid mechanics represent the 3D material flows Experimental results are also used to study effect of process parameters on joining properties of friction stir welding

Elengovan et al (2007):-Elengovan studied the tool pin profile and welding speed of the friction stir welding. In the fabrication required a high strength to weight ratio for light weight structure. in this investigation he studied the effect of tool pin profiles and welding speed on the formation of friction stir processing zone in AA2219 aluminium alloy.

Chen et al (2008):-Al-Si alloy and pure titanium are joined using FSW technology. The microstructure and tensile properties are examined Then maximum failure load is reached at 62% of Al-Si alloy .The microstructure evolution and joining mechanism of joints are discussed.

Moreira et al (2008):-In the friction stir welding studied the mechanical and metallurgical characteristics of butt joints of aluminium alloy 6061-T6 with 6082-T6. Two alloys are used for the similar material joints .the tests are applied on the materials. After doing tensile test dissimilar joint displayed intermediate properties

Rodrigues (2008):-In this research paper present work of 1 mm thick plates of AA 6016-T4 aluminium alloy are used with two different tools .properties of tool are analysed. In order optimised the welding parameters then achieve non-defective welds.TEM micro structure analysis explained the difference mechanical properties between the two types of weld. Cold weld improve the drawing performance of the welded sheets

Muthukumaran et al.(2008). States that during elastic to plastic deformation of metal and alloy electromagnetic radiation is emitted. Today al plat welded by using FSW by using different process parameter such as traverse speed and rack angle. Fundamental frequency variation was analysed by using MATLAB. it is observed that increase in first mode of metal transfer decrease the fundamental frequency

Chen et al. (2008) Al- Si alloy and pure titanium were lap joint using friction stir welding .tensile and microstructure properties of joint were examined .

Rodrigues a (2008) friction stir weld produced in 1mm thick plate of AA 6016-T4 Al alloy. With various tool, compared concerning the mechanical properties and microstructure for tool, parameter of welding were optimize in order to achieve non-defective welds. In mechanical properties there differences between the two types of weld are explained based in TEM micro structural analysis.

Jai KWON et al. (2009) performed the friction stir welding between 5052 al alloy plates with 2mm thickness was performed. Welding tool was rotates at speeds ranging from500 to 3000 r/min under a constant traverse speed of 100mm/min

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III.CONCLUSIONS

FSW is a new welding technique which is ecofriedly and economical.FSW has been successfully applied to wide variety of difficult to join materials. Mechanical and Physical Properties obtained in most of the cases are superior. Advantages of FSW are Low distortion, no spatter, no fumes. Welding will be done at plastic state of materials below the melting point of metals and alloys.Tool life is high enough for high end applications, and increasing. Better forging action has been obtained by tool.FSW Creates high strength welds in hard to weld metals. It can be used as an alternative to fusion weld.

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