**Review of Friction stir welding (FSW)**

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**Abstract:-**

A type of steel weld known as friction stir welding (FSW) is utilized. A utilized device which could be utilized for joining two works without them. Dissolve the workpiece. Friction between the workpiece and the tool causes thermal to be produced. Solubility isn't eased by this heat; just metal is. For joining its goal, the tool glides over the surface that is softening. Welding range expands as needed on a daily basis. The investigation of the FSW method, microscopic features, mechanical characteristics, and heat soldering function are the basis for this research. Treatment of joints, experiment design, Joints of aluminum and their alloys.

**Keywords**: Solid type welding, Welding properties, Non-consumable tool, Mechanical properties, FSW process analysis, Post weld heat treatment of the joints, Microstructural properties, Design of experiments, Corrosion of the joints.

**1- Introduction:-**

The primary goal of the literature review is demonstrating how previous works in friction drives the welding regarding aluminum alloys. This literature review was written with the intention of assisting other researchers who require detailed information about a prior welding operation. Researchers at the Welding Institute (TWI) in Cambridge, U.K., have created the welding kind of steel called heat FSW for joining panels. Utilize combinations for imposing the task on back panel for stopping the lateral. Combinations are used to impose the back panel and stop the lateral. [1]

A pin from which the tool is stretched causes the shoulder to spin many hundred rounds per minute. The pin is driven into the work-piece to the point where it touches shoulder surface. The friction is created between them as a result of their shoulder contact.

In a space between two faces, the tool moves. The weld cools and then joins as the tool moves. Using conventional welding techniques, like fusion welding, was done after the tool was removed. The primary disadvantage of fusion welding is the full change in microscopic structure and loss of mechanical characteristics that occurs following welding. Due to the FSW's solid welding condition, the problem may be entirely avoided. Additionally, FSW has a few benefits in the case when put to comparison with conventional welding techniques.

1- FSW is produced without the use of fillers.

2- There is no need for shielding gas with FSW.

3- No arc or smoke is produced.

4- Less distortion and pressure are applied to FSW Basic Materials by FSW.

There is no need for the skilled professionals. [2]

The solid welding type prevents cracking and porosity from forming. Depending on microstructure, FSW welded area is divided into 4 regions: the stress zone, heat-affected zone (HAZ), thermal mechanically affected zone (TMAZ), and unaffected zone (SZ). A area in which microstructure is not altered is referred to as an unaffected area. Heat does not alter the features of mechanical objects. Comparable to fusion welding, HAZ is the area in which heat can impact both mechanical qualities and microstructure. The area where mechanical characteristics are impacted by the heat has been known as mechanically damaged zone. The original grain boundaries are placed in the noise zone. [3]

**2- Literature survey**

Welding Institute (TWI) Thomas et al. (1991) examined the problem with fusion welding of an aluminum alloy because FSW prevents the production of surface oxides in base material. In order to join metal, FSW employs a consumable tool that generates heat due to base material friction [1]

Through changing the fixed location regarding the materials, Lee et al. (2003) conducted a research depending on joint characteristics for different cast A356 and wrought AA6061. The longitudinal tensile tests revealed that in the case when placed on the side of retreating, AA6061 has a stronger stir zone compared to A356. [4] Peel et al. (2003) changed welding conditions, like rotational speed, tool design, and translational speed, to use AA5083 aluminum alloy for FSW. The results of mechanical analysis and residual pressure tests on the four pieces of AA5083 aluminum showed that heat input, rather than tool deformation, affects the parameters of welding. [5] Cavalierre *etal*. (2006) have investigated FSW tensile as well as the fatigue behavior regarding alloys 7075 and 2024. In the tensile test, it has been discovered that 2024 fails because of lesser hardness, while 7075 fails because to shorter fatigue life. [6] Steuwer *etal*. (2006) have found that AA5083-AA6082 process parameters have an effect on the residual stress. Also, found that, particularly in the case of AA5083, the welding speed in welding tools is of higher quality compared to the spin speed regarding the remaining pressure. [7] According to Lee et al. (2008), under various welding parameters, the interface geometry related to AA5052-H112 and AA6061-T6 has an effect on the joint's tensile performance. It was discovered that lower welding speeds and faster spin velocities reduced the fracture load. [8]

Through selecting three rotations as well as welding speeds, Sayer *etal*. (2008) examined the impact of process parameters for FSW on mechanical characteristics, microstructure, and low fatigue behavior regarding the cycle of aluminum alloy plates of AA6063. Throughout tensile test, it was discovered that the majority of samples broke between HAZ and TMAZ. It has been found that base metal accounts for 70% of welding properties. Additionally, low cycle fatigue life of the welded specimens has decreased by 40%. [9] Sunggon et al. (2008) changed the process parameters, like the rotation and welding rates, to examine the tensile behavior related to the FSW of AA6061-T651. The friction elongation ratio in AA6061-T651 material reduces with the increase in the spin speed or slower speed of the welding, according to tensile test. The effect of process parameters also affects the maximum as well as yield tensile strength. [10] According to Lohwasser (2009), FSW can accommodate the pin driven flow and shoulder flow, 2 different types of material flows. The firm bonding of materials is impacted by the creation of oxide layers. With the use of the tool shoulder in FSW prevents the production of this oxide layer. The working temperature regarding FSW is approximately 0.60 – 0.90 times the temperature of the melting.[11]

In their 2009 study of mechanical behavior on joints made of dissimilar alloys AA60616-T4 and AA5182-H111, Leitao et al. have examined that tensile strength of joints for AA5182-H111 completely dependent on grain size. According to studies examined A413 and A319, the welded joint loses ductility. [12] Through varying the speed regarding the passage from 50mm/min to 175mm/min, Sakthivel *etal*. (2009) examined the effects of various speeds of welding with regard to FSW on the mechanical and metal features of the alloys. Because of a lack of thermal input, it was discovered throughout tensile testing that the maximum tensile strength decreased as movement speed increased. On the other speed, higher heat generation happens when welding happens more slowly. [13] According to Dhilip et al. (2010), the specifications regarding the materials to be joined as well as the process parameters, material placement, and tool positioning all affect the welding related to dissimilar metals in FSW. [14] Sundaram et al. (2010) used five different pin profiles to assess the FSW for AA2024-T6 and AA5083-H321. By examining the flat cylindrical pin, triangular pin, and cylindrical threaded profile, it could be seen that a cylinder with taper tool pin diameter is one of key factors influencing tensile strength. They also discovered that a defect-free weld is possible at speeds between 300 and 700 rpm, 15 to 35 mm per minute, and 4 to 8 kN of axial force. [15] The tensile properties regarding the dissimilar welds AA5083 and AA2219 were altered in FSW by Koilraj et al. (2012) with the use of 5 tool profiles, like transversal speed, rotational speed, and D/d ratio, in which D represent the shoulder's diameter and d represent the tool pin's diameter, which are parameters that have been taken into consideration for this study.[16]

**3- Parameters of FSW**

With regard to welding and process control, independent process variables are crucial. Axial force of the fall, ignition angle, turning tool rotational speed, welding speed, and tool engineering are process variables. The aforementioned factors have a significant effect on the rate of thermal generation, the process's need for mechanical energy, the temperature distribution within the work material, the distribution of loads within the work material, and the evolution of welding material. As depicted in the figure, there are 3 different types of the tools for the FSW: adjustable, fixed, and RFID with the same. One piece with a probe and a shoulder is compatible with fixed scan tool (Fig. 2a). Because of the length of fixed probe, this welding tool might just work with a fixed thickness. The probe should be totally replaced if it is severely damaged or broken. The shoulders regarding the tool are made to be thermally relevant to the friction piece of the workpiece's surface area, and the creation of angles is required to standardize welding and prevent hot metal from contacting the lower shoulder's surface. The rotary tool's rotation speed, the workpiece's degree of ductility or plasticity when working with material interface, applied axial load, and design tool all have a significant tool on the torque produced by the welding process.[17]

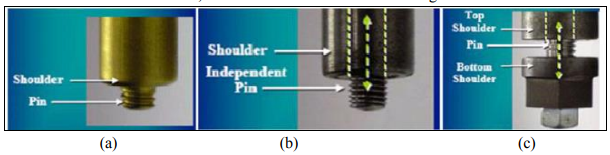


Figure 2: Different Tool configuration,

It was investigated how welding and rotation speeds affected the mechanical characteristics as well as the microstructure of pristine tool (BT-FSW) Mg AZ31. The findings demonstrated that the TMAZ was made up of equal granules, in contrast to the distorted, controlled, and rectangular grains discovered in TMAZs for pulley abrasion, the alloy of inverted frictional alloys, and friction aluminum. S.Yu.Tarasov et al. [18] (2014) From the standpoint of the study regarding the tribal layer and its interaction with the instrument's metal, the propagation corrosion process in the FSW 1.2344 X40CrMoV5-1 tool for steel was studied. By breaking along the distinct grain boundaries under shear stress that was created on tool's surface during FSW, it is suggested that FSW fragments can be deformed and separated from FSW. Juan Chen and others [19] (2015) Convex and precipitated (DFSW) tools were used in conjunction to study double-sided FSW (DFSW) for bonding magnesium alloys. The concave-DFSW acoustic joints. Under the right circumstances, it was feasible, and the joints had a distinctive structure for the stirring area that was different from the traditional FSW with a single-sided tool rotation. By speeding up the concave instrument's rotation, the average grain size in the stirring area was reduced. This finding implies that friction and plastic deformation both contribute to thermal generation during FSW. Convex tool fabric in the stirring area created a composite mineral flow that offers preferred tensile behavior.

K. Kumaria et al. [20] (2015), in FSW method, a double tool is created to conduct a study between a double tool and a single tool. The dual device aids in producing high thermal levels that cause the treated area to exhibit high plastic deformation. The effectiveness of seamless welding depends on the interaction between welding speed and spin speed as well as rotation speed alone. A higher hardness value is produced via fast welding and rotation. In this combination, the joints of the defect are also noted. Additionally, a pleading failure is explained by SEM results that show microscopic holes of varied shapes and sizes.

**Summary:-**

1. FSW is a highly reliable and successful solid-state bonding process.
2. FSW has a number of advantages over the conventional metal bonding process.
3. FSW has a very broad range of applications in fields including automobiles, shipbuilding, and space.
4. The field can be further studied Double pass sold FSW tool and also metal study for FSW Metal.
5. The gap between two consecutive FSW tools and its tool on the quality of the welding could also be examined.

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مراجعة عن اللحام بالمزج الاحتكاكي

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الخلاصة: لحام المزج الاحتكاكي هو عبارة عن لحام فولاذي يستخدم أداة مستهلكة يمكن استخدامها لربط معدنين بدون عملية ذوبان. يتم توليد الحرارة بسبب الاحتكاك بين القطعة المراد لحمها والأداة. هذه الحرارة تتولد بين قطعة العمل و الاداة. تتحرك الأداة على طول سطح الربط لتفيذهذا الغرض. نطاق اللحام في زيادة يوما بعد يوم وفقا لاحتياجاتهم. يستعرض هذا البحث أساس تحليل عملية اللحام بالمزج الاحتكاكي ، والخصائص الميكانيكية ، والخصائص المجهرية ، و وظيفة اللحام الاحتكاكي، وتصميم الملحومات في الألومنيوم وسبائكها.