FRICTION STIR WELDING

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I.ABSTRACT

Using experimental welding data and thermal modelling the transient heat losses into FSW tools were calculated. Heat loss into the tool enabled the welding efficiency to be determined. The body of this work covered the welding of two light alloys using solid steel tools. Finally the use of grooves in the tool to impede heat flow was investigated as a way of increasing welding efficiency.

The work concludes that using solid tools the steady state heat loss into the tool is about 10%of the total heat generated; for short welds that start with a cold tool this can be higher. Grooves in the tool shank increase the thermal efficiency and stability of the welding process.

Keyword:- *1. Friction 2. Welding 3.Tool 4.Stir 5.Analysis of welded Part.*

II. INTRODUCTION

Friction Stir Welding (FSW) was invented by Wayne Thomas at TWI (The Welding Institute), and the first patent applications were filed in the UK in December 1991. Initially, the process was regarded as a “laboratory” curiosity, but it soon became clear that FSW offers numerous benefits in the fabrication of aluminium products.

In FSW, a cylindrical shouldered tool with a profiled pin is rotated and plunged into the joint area between two pieces of sheet or plate material. The parts have to be securely clamped to prevent the joint faces from being forced apart. Frictional heat between the wear resistant welding tool and the work pieces causes the latter to soften without reaching melting point, allowing the tool to traverse along the weld line. The plasticised material, transferred to the trailing edge of the tool pin, is forged through intimate contact with the tool shoulder and pin profile. On cooling, a solid phase bond is created between the work pieces.

III.PROCESS PRINCIPLES

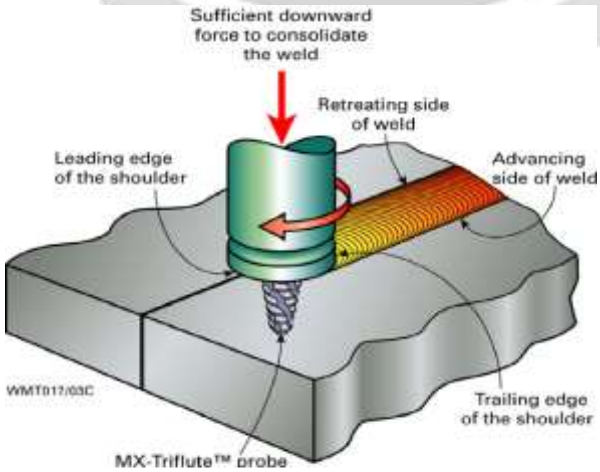

Fig. Process principle for friction stir welding

A constantly rotated cylindrical-shouldered tool with a profiled nib is traversals fed at a constant rate into a butt joint between two clamped pieces of butted material. The nib is slightly shorter than the weld depth required, with the tool shoulder riding atop the work surface.

IV.Steps of the Process

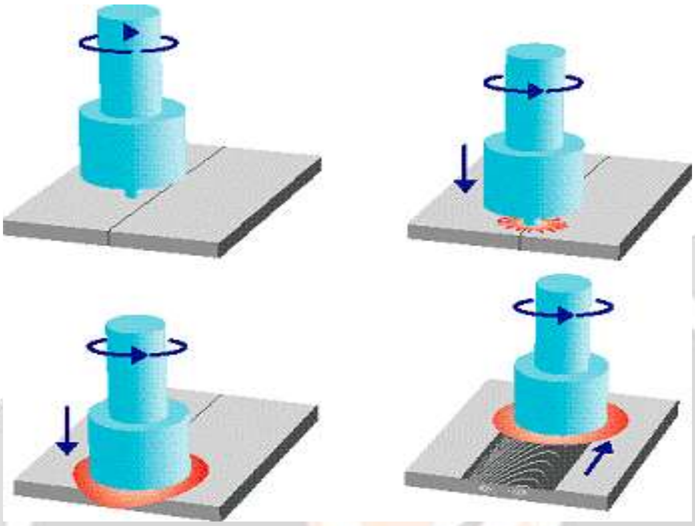

Fig. Steps of the Process

- Frictional heat caused by the rotating pin creates a plasticized tubular shaft around the pin.
- Pressure provided by the weld tool forces the plasticized material to the back of the pin, cooling and consolidating.
- Cross section of weld pin tool into base material and the subsequent "stir" action taking place during a weld.

V.FIXTURES & ATTACHMENT

Fig. Fixture & Attachments

As the FSW involves rotating of the tool at high speeds, plunging it into the workpiece, and transverse feeding of tool in the direction of weld joint and for all these operation to be performed. The very first requirement is rigid clamping of the work-pieces opposite each other. During the traversing movement there are a lot of pressure on the work-pieces forcing them apart from each other. These forces have to be opposed by the clamping the workpiece rigidly to the worktable.

VI. MATERIAL & PREPARATION

Material consist of what are the different material can be successfully welded by using this technique & preparation consist of welding setup that is required for start to completion of welding. This can be divided into three categories

1. Weldable material
2. Set up of welding

6.1.WELDABLE MATERIAL

Firstly the friction stir welding was used to join the materials like aluminium & its alloys. But after research it can be used to weld the material like copper, brass. Further research is results into welding of steel, zinc, magnesium, niobium, molybdenum, titanium, zirconium alloys.

The two different material can be welded must be have the melting temperature near about. That means that aluminium & brass can be welded together.

6.2.WELDING SET UP

Some convention welding required weld edge preparation, weld tack, required time consuming inspection that is not case with the friction stir welding. For joining flat plates it requires straight edge, which must be rigidly clamped, & path of the tool is given according the weld line. For joining irregular shape it required similar set up.

VII. TOOL DESIGN

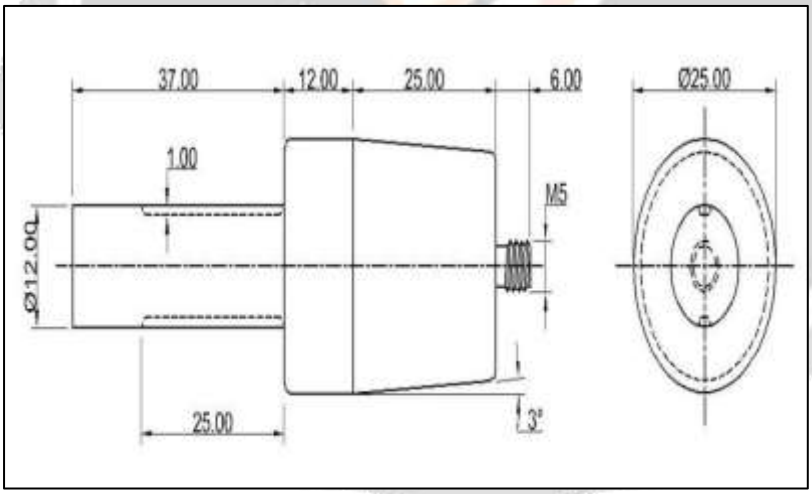

Fig. Design Friction Welding Tool

For generation of friction, flat should was developed which would rub while rotating against top surface of the two plates at the joining line. The diameter of the shoulder be optimum e.g. a tool with shoulder diameter less than required would generate less frictional heat therefore more dwell would be needed in such case or otherwise more downward force have to be exerted than required to increase the contact pressure which would result in increased forces and load on the machine. Alternately a tool having shoulder diameter more than required would generate more frictional heat but the increased contact area would increases wearing of tool shoulder. Hence optimum contact area i.e. shoulder diameter of 5mm was selected for 5mm thick aluminium plates.

VIII.FRICTION STIR WELDING MACHINE

Fig. Friction stir welding

For doing friction stir welding three movements are required first the movement in X direction. i.e. horizontal movement second the movement in Y direction i.e. longitudinal movement both this movement are required for alignment of the workpiece. Third is the downward movement of the tool. By giving these three movements & according to the shape of the welded part the FSW machine should be designed. It is not suitable for non-production use because

1. The required tool path is very difficult to change according to different geometry of a work-piece.
2. High strength and rigidity is required because high true speed so it has limited portability. Now our aim is to make the working model so by considering above statement, the requirement of this machine suits drilling cum milling machine (structure of drilling machine and different motion of radial drilling machine. So we decided to make this machine. The photograph of this machine is shown as below. It consists of the following parts.)

IX.ANALYSIS OF WELDED PART

Analysis is must required after completion of any Process or technique as it gives us the results that whether the process is advantageous or not. Analysis of welded parts contain what are the different zone forms during the welding, what is the microstructure of the welded part & the strength of the welded part & this strength is then compare with the base metal so that after analysis we know the efficiency of the process.

9.1.Microstructure

The microstructure of friction stir weld depends in detail on the tool design, the rotation and translation speeds, the applied pressure and the characteristics of the material being joined. There are three zones to consider in the microstructure of a friction stir weld; the heat affected zone the thermo mechanically affected zone & the zone also called as weld nugget. The three different zones are shown below.

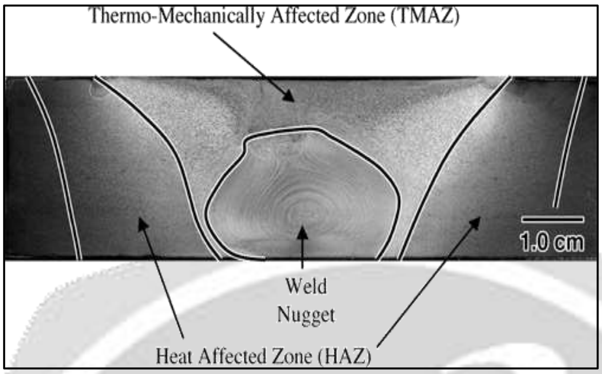

Fig: Heat affected zone (HAZ)

9.2.Heat affected zone (HAZ)

In this region, the material has been plastically by the friction stir welding tool, and the heat from the process will also have exerted some influence on the material. In the case of aluminium, it is possible to get significant plastic without recrystallization in this region, and there is generally a distinct boundary between the recrystallized zone and the deformed zone of the TMAZ

9.3.Weld Nugget (Stir zone)

The recrystallized area in the TMAZ in aluminium alloys has traditionally been called the nugget. Although this term is descriptive, it is not very scientific, However, its use has become widespread, and as there is no word, which is equally simple with greater scientific merit, this term has been adopted, A schematic diagram is shown in the above Figure, which clearly identifies the various regions. It has been suggested that the area immediately below the tool shoulder (which is clearly part of the TMAZ)

9.4. Mechanical strength

The solid-phase weld formation produced by FSW provides three important metallurgical advantages when compared to fusion welds in aluminium alloys; first, joining in the solid-phase eliminates cracking; second, there is on loss of alloying elements through weld metal evaporation and the alloy composition is preserved; and finally, the crushing, stirring and forging action of the welding tool produces a weld metal with a finer grain structure than that of parent metal.

The following table gives the data of analyzing tensile test.

	Load (KN)	**le stress(N/mm2)**	**longation %**
velded metal	35.21	298	23
Base metal	35.53	298	23

The above test result is of aluminium plate 5mm thick & 50mm long; from above table we can conclude that the properties of weld metal in tension is approximately same as that of the base metal.

X.ADVANTAGES

- The welding process does not require filler wires and pool- shielding gas.
- Special joint edge profiling is unnecessary
- Oxide removal immediately prior to welding is unnecessary
- The technique is ideally suited to automation
- If necessary the welding operation can take place in all positions from down hand to overhead.

XI. APPLICATIONS

- Panels for decks, sides, bulkheads and floors
- Aluminium extrusions
- Hulls and superstructures
- Helicopter landing platforms
- Marine structures
- Refrigeration plant

XII. FUTURE DEVELOPMENT

Man is always trying to develop more and more modified technique with increasing aesthetic look, economic consideration & to facilitate production, always there is little bit scope of modification.

From starting of project on FSW we know that we have to perform a lot of experiments concerning the speed of the tool, microstructure and grain size of welded part etc. As it is a relatively new concept and as far as our knowledge is concern on one industry in Mumbai or even in India using this technique. So we have only initial idea of it. So we give maximum time to it and start of working on it. But being diploma engineers and having the ability to think and plan. But due to some time constraints, and also due to lack of funds, we only have thought and put in the report the following future modifications. :-

1. Tool
2. Automated machine
3. Fixtures

10.1.Tool

We manufacture the cylindrical shoulder tool with right hand thread on the probe. But the shape of the probe could be flat shoulder, concave shoulder, plane cylindrical probe, threaded paper probe, straight flute probe, threaded probe with spiral and one of the most useful retractable tool in which the length of the probe of the tool can be varied so that one can be used for different thickness of the workpiece.

10.2. Automated machine

Mass production we can use automated machine in which all the motion in which we can he motions by remote. A robot can also be used to do **FSW** in which different part can be programmed according to the workpiece and weld requirement.

XIII.CONCLUSION

FSW is here to stay. The process has demonstrated its capabilities and been approved as a novel method for joining aluminium and other metals. FSW is opening up totally new areas of welding daily. The welding process improves existing structural properties and leaves the weld “cold”. In some cases, if proper care is taken, weld properties equal those of the base material.

Anyone currently working with aluminium could be using FSW. It is within everyone’s reach. It is just a question of daring to use it, eliminating the smoke and spatter typical of arc-welding. The choice is yours!

XIV.ACKNOWLEDGEMENT

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