FRICTION STIR WELDING THROUGH FABRICATED SETUP BY USING CONVENTIONAL HAND DRILLING MACHINE

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***Abstract*- The present work is based on the motivation to bring the technique of friction stir welding in workshop level so as to weld metals having low temperature such aluminium, lead, etc. As the friction stir welding is an environment friendly joining process. Through this paper an initiative is taken to introduce this recent technology of friction stir welding in the workshop level because friction stir welding is common to scholars and researchers but an uncommon in general. In the present work, we have fabricated low cost setup of friction stir welding by using conventional hand drilling machine for exploring and sharing such a nice invention and gift to humanity given by The Welding Institute, England. As far as life of welder is concerned, our fabricated setup can heal the wounds of the welders suffering from various diseases. An initiative has been taken to fabricate low cost setup of friction stir welding because the actual machine of friction stir welding is very expensive and costly as well as the experimentation of this technique is also costly because the owners of machine allow to work but on high charges. The experiment was performed on the fabricated setup and the workpiece plates were successfully joined through friction stir welding technique. After successful joining, the workpiece was tested for bending and striking test and it was found that the workpiece was safe after the testing which shows the reliability of joint and opens the door for young minds to work further on this technique in order to make this method more familiar in general.**

Keywords*— *Friction sir welding, Fabricated setup, Hand drilling machine, tool, workpiece.

I. INTRODUCTION

Friction stir welding (FSW) is a welding technique, invented by The Welding Institute (TWI), Cambridge, UK as a solid-state joining technique in the year 1991. Initially this technology was applied to aluminium alloys. Friction stir welding is based upon the simple concept of heat generation due to friction. The tool serves two primary functions including heating of workpiece as well as the movement of material to produce the joint. The heating is accomplished by friction between the tool and the workpiece and plastic deformation of workpiece. The localized heating softens the material around the pin and combination of tool rotation and translation leads to movement of material from the front of the pin to the back of the pin [1]. This method is environment friendly joining process and it is highly required in Indian scenario [6].

In the present work, we have fabricated low cost setup of friction stir welding by using conventional hand drilling machine for exploring the concept and application of friction stir welding for joining the low meting point metals and alloys which is very difficult to weld by using conventional welding processes such as Arc welding, MIG welding, TIG welding, etc.

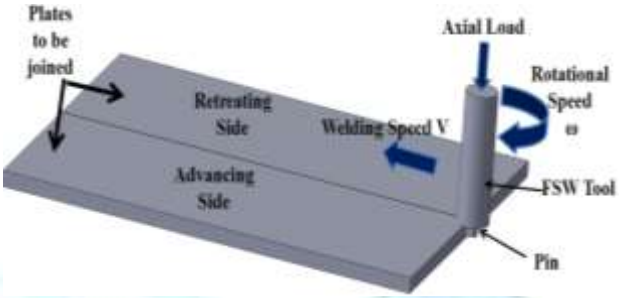

Fig 1. This figure shows friction stir welding process by using a rotating tool which moves in the direction of joined edges of plates [7].

II. FABRICATION OF FRICTION STIR WELDING SETUP

The steps of fabrication are discussed in this section of the report. We have used the commercial drilling machine for the operating the tool due to its high RPM and torque. Figure 2 shows the fabricated setup of friction stir welding by using conventional hand drilling machine. This fabricated setup is used for joining of low melting point metal plates.

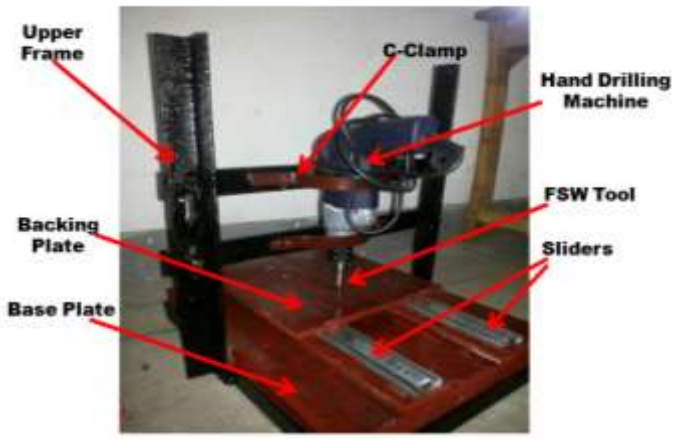

Fig. 2. The Fabricated Setup

As the drill machine takes a sudden bumps it is essential for us to make "C" frame that can with stand such forces. The machine is clamped in the frame by the means of nut-bolts and slots are provided at the side of the frame for the adjustment of the machine. The welding tool we have used here is made up

of MS rod by our own hand on the lathe machine provided by the university in our workshop. In our model of FSW machine we had fixed the drilling machine where as the plate holding the work piece moves. The base plate is fixed on to a sliding mechanism which allows it to slide. This wooden base plate is covered with a layer of GI sheet for the purpose of increase in strength. The work piece to be joined is clamped on this plate and the machine is allowed to starts following by the sliding of the base plate by hands as the welding process completes. The steps of fabrication are as follows:

- Design of friction stir welding setup
- Cutting of the base frame
- Cutting and fitting of the wood
- Installing GI sheet
- Slider Base preparation
- Fitting Slider base on Main Base
- Fitting of Slider
- Fitting of the baking plate
- Fabrication of the upper frame
- Drilling hole and making slots
- Fitting of drill machine
- Tightening of the Hand drilling machine
- Fabrication of the tool on lathe machine

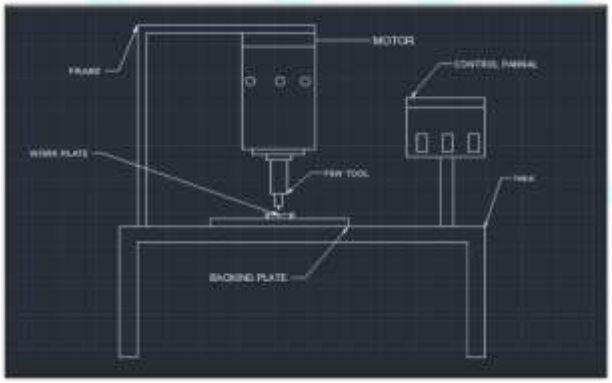

Fig. 3 The design of setup was done on student version of drafting software AutoCAD® from Autodesk®.

Fig. 4 Fitting of slider to slider base.

Fig. 5. Fitting of Drilling machine

Fig. 6 Fabricated MS tool fitted on drill chuck of the setup

Cutting of base frame was done by using Hydraulic Power Hacksaw available in Fitting shop of our Workshop. The wooden base was selected for reducing the weight of the setup. Cutting and fitting of wood for base was done by using Hand Hacksaw. The wooden base was decided to cover with GI Sheet so as to make it more heat resistant and also for giving metallic look to the setup. The Slider base was also selected to make from wood for reducing the weight of the setup. The slider base was fitted to main base of the setup by using hammer and nails in order to provide more strength to the setup. In order to make workpiece movable the slider was introduced in between backing plate and base The MS frames were selected for fabrication of Upper frame so that it can bear the load of the hand drill machine. In order to make the drill machine adjustable, slots were made so as to make the setup flexible to weld a range of thickness of the workpiece. The drill machine was fitted by using C clamps fabricated us. Joining of the fabricated frame was joined to the base of the FSW setup by using Arc welding in the Welding shop of University Polytechnic. The conventional Hand drill was purchased from the market for availability of high torque and required rotational speed. The FSW tool was selected for the setup was of Mild steel due to its availability and strength as compared to the workpiece materials like Aluminium and Lead alloys. In order to clamp the setup the Workpiece, the clamping system was generated by using strips of mils steel bolted with the backing plate so as to provide fixation to the workpiece for smooth welding .

III. EXPERIMENTAL PROCEDURE

After the successful fabrication of friction stir welding by using the conventional hand drilling machine, The experiment of friction stir welding was conducted on Lead alloy plate as a workpiece and FSW tool made of mild steel.

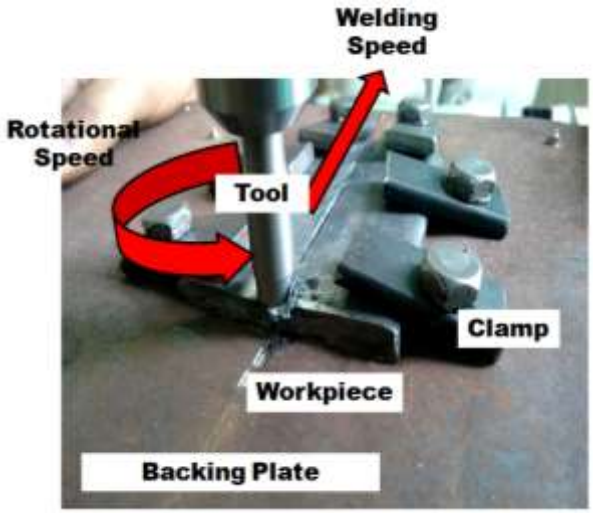

Fig. 7 Experiment of FSW by our Fabricated Setup

Fig. 8 Start of FSW Process

Fig. 9 During FSW Process

Fig. 10 End of FSW Process

Fig. 11 Successful Joining of Lead alloy Plates

A. Experimental Specifications

- *Hand Drilling machine-(IMPACT)*

RPM-2600
240volts
0-10mm chuck side

- *Work piece (Lead alloy)*

Length-9cm
Breath-3cm
Height-0.5cm

- *Tool (MS)*

Diameter-7mm
Height-6cm
Pin diameter-1.5mm
Pin height-2mm

Maximum/Minimum clamping length-12cm/3cm
Maximum/Minimum clamping breath-8cm/4cm

Welding Length WL=90mm
Time consumed during welding t=93sec

$$WS = \frac{WL}{t}$$

Welding Speed calculated is 0.96mm/s

IV. MANUAL TESTING

The Friction stir welded plate was undergone through testing for confirmation of joining phenomenon.

Fig. 12 Bending Test

Fig. 13 Striking Test

V. CONCLUSIONS

After successful fabrication of friction stir welding setup by using conventional hand drilling machine, following conclusions can be drawn:

- The low melting point metals unable to weld from Arc welding can be successfully welded by using our fabricated setup at workshop level.
- As the Friction stir welding technique is common to the researchers but uncommon in general, This kind of initiatives may spread this technology at workshop level.
- There is successful joining of two metallic plates without any fumes, radiations, harmful gases, flames, etc.
- The welded specimen was safe after the level of manual testing, it shows the reliability of the friction stir welded joint.
- The fabricated setup is user-friendly due to its features such as adjustable height of hand drilling machine & tool, variable travel speed, easy changeability of tool, less weight and portable.

VI. SCOPE OF FUTURE WORK

- The Welding parameters clamping size, tool geometry, welding angles and directions can be made variable.
- Whole setup can be automated.
- Tool rotational speed can be made variable by introducing a resistance based regulator.
- A more stable design can be made.
- More materials with high melting point can be welded by changing the geometry and the material of the tool.
- Temperature measurement can be done during friction stir welding process by using Thermocouples.

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