Design And Fabrication of Friction Stir Welding

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Abstract- *The aim of the project is to design and manufacture a compact welding machine which will impart higher accuracy during welding of two metals. The principle of this welding machine is to join similar metals by high speed drilling head with friction tool. The joining in this process comes into consideration because of friction. By implementing this machine there will be boom in the production though it reduces the production time. The machine is well suited for mass production industries. Friction stir welding is a joining process that uses heat energy which is generated through the mechanical friction between work piece in relative motion to another with the addition of a lateral force called "upset" to plastically displace and fuse the material. Basically, Friction welding is not a welding process though no melts occurs rather we can say that it is a forging process. In this project we have improvised the friction welding process by introducing a low cost simple friction welding machine.*

Keywords- Friction Stir Welding, Aluminium

I. INTRODUCTION

It was invented and experimentally proven by at The Welding Institute (TWI) in the UK in December 1991. TWI then established TWI group-sponsored project 5651. It is popular due to following reasons:

1) Good mechanical properties at welding conditions.
2) Improves safety due to absence of toxic materials.

Manufacturing Industries are developing rapidly and they are adapting new techniques to join metals and one of the method to join metal is welding. Welding is the process of joining two similar or dissimilar metal with or without the application of pressure. Welding can be achieved by melting edges of metal piece or brought it to the plastic conditions. Welding is incorporated for permanent joints. Welding found applications in Automobile bodies, Aircraft frames, Railway Wagon, tanks, boilers and many more. Now a days every manufacturing Industry is using welding processes for joining of the metals.

II. METHODOLOGY AND PROBLEM STATEMENT

A .Problem statement

Aluminium is used in most of the industrial application today such as in building aircrafts and automobile parts where the strength to weight ratio is very important. However while welding the aluminium many problems are faced due to which good quality of welding is not obtained. The main problem while welding aluminium is that it reacts with oxygen in the air to produce a thin hard film of aluminium oxide on the surface. The melting point of aluminium oxide is approximately 2052˚C. This aluminium oxide film, particularly as it becomes thicker, absorbs moisture from the air. Moisture is a source of hydrogen, which is the cause of porosity in aluminium welds. To avoid these problems it is very necessary to control the heat generated during the welding in order to avoid problems like burn-through and distortions, because the material heats up very quickly. Therefore, to reduce the heat the heat affected zone lowest possible heat input is given.

B. Methodology

Friction Stir Welding machine is developed in order to weld the aluminium alloys effectively without affecting their properties. Literature review is done in order to understand the various factors that affect the amount of heat generated during the friction stir welding process. The main factors on which the welding quality depends in FSW are the rotation speed of the tool, transverse speed of the work piece and the shape of the tool. The components that are identified for the manufacturing of FSW machine is lead screws, motor, mild steel tool, bench vice and aluminium work piece. A CAD model of the machine is designed by using CREO PARAMETRIC 2.0. The fabrication of the machine is started by selecting proper material and certain modifications are made in the design according to the requirement.

III. DESCRIPTION OF COMPONENTS

1) Motor: Motor is a gadget which is utilized to change over electrical vitality into mechanical work. A 3-Phase AC engine is utilized so as to give the rotational movement to the apparatus. The engine pivots with the speed of 1440 rpm with 0.5 HP. The engine shaft is associated with the device with the

assistance of hardware holder and the apparatus rotational speed of hardware is thoroughly relies on the engine speed.

2) Lead Screw: A lead screw, otherwise called a power screw or interpretation screw, is a fasten utilized as a linkage a machine, to make an interpretation of transforming movement into straight movement. We use lead tightens this venture for accomplishing the vertical and flat development of the instruments. The length of the lead screw is 1.5 feet with a pitch of 3mm. One lead screw is utilized for the vertical movement of the engine and two lead screws are utilized to modify the situation of the workpiece as indicated by the necessity.

3) Workpiece: As FSW is utilized to weld aluminum combinations so we select the material for workpiece as Aluminum Alloy (AA6061) with a thickness of 2mm. This workpiece is fitted in the bad habit and the welding is finished with assistance of grinding produced in the middle of the workpiece and the device.

4) Tool: The material of the instrument is chosen as gentle steel. The instrument is associated with the engine with the assistance of hardware holder and the movement of the engine is transmitted to the apparatus. The instrument vertical movement is constrained by the vertical lead screw. The apparatus profile is a vital factor which straightforwardly influences the welding quality. So as to limit the warmth influenced zone, the device profile is chosen as roundabout.

5) Vice: A Vice is a mechanical device used to verify an item to enable work to be performed on it. Bad habit have two parallel jaws, one fixed and the other portable, strung in and out by a screw and switch. The workpiece is fitted in the bad habit with the goal that it ought to be inflexibly fixed against the vibrations that would produce amid the welding procedure. The situation of the bad habit can be balanced by the two lead screw arranged at the bed.

6) Frame: This is made of mellow steel material. The entire parts are mounted on this casing structure with the appropriate game plan. The entire vibration produced amid the welding procedure is consumed by this edge structure. The vertical segments are of L segment and the counts are made to check whether it can continue the heap and it is observed to be protected.

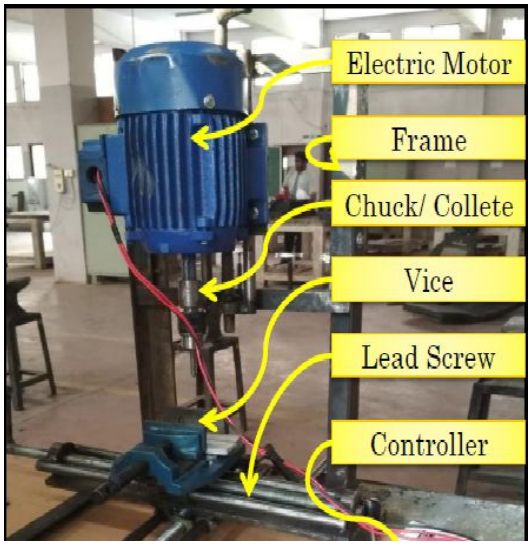

Fig.1 Components of Machine

IV. WORKING

Friction stir welding friction is used to generate heat at the metal surface. This heat starts diffusion process on metal surface. Due to diffusion process joint is created and two metal pieces are joined together. In friction stir welding process Aluminium work plates are clamped on the vice which is mounted on the Bed. Tool is attched to the motor with the help of chuck. Tool is moved vertically with the help of handle which is operated maually. Rotating tool having speed 1440 rpm is inserted into the work plates. Tool is inserted 1mm inside the work plates. This will deform material plastically due to heating by friction force. This is state of the joining process in which, inter molecular diffusion will deform the material plastically due to heating by friction force. Now the vice is moved in longitudinal direction with handle manually. The Bed continously moved untill the whole weld is formed. After the joining process, the tool is separated from the work plates. After that aluminium plates are removed from clamp and welding process is completed. The heat generated during this process is very less and thus it does not affects the properties of the alunimium and avoids problems like burn-through and distortions.

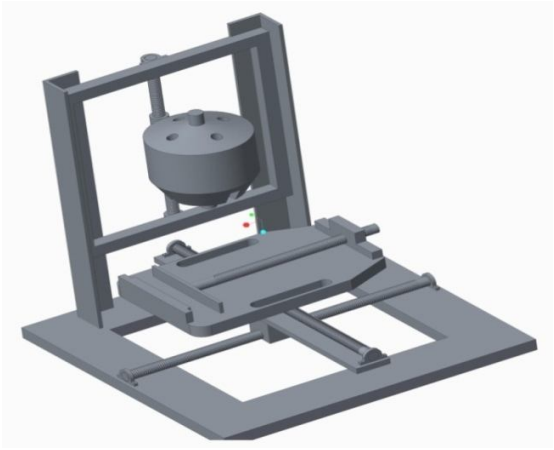

Fig. 2 CAD model of Machine

V. DESIGN OF LEAD SCREW

Mild Steel Properties –
Sye = 324 Mpa
Sys = 197 Mpa
σcr = 129.6 Mpa
τpermissible = 78.8 Mpa

$P = \sigma c \times \pi/4 \times dc^2$
$12\times10^3N = 129.6 \times \pi/4 \times dc^2$
c = 11 mm
dc = 1.2 × 11
dc = 13.2mm
do = dc/0.84 = 13/0.84
do = 16 mm
Pitch
P = do-dc P= 3mm
dm = (16+13)/2 = 14.5 mm

To check : σc
$P= \sigma c \times \pi\div4 \times dc^2$
$12\times103=\sigma c\times\pi\div4\times132$
σc=90.40mpa
σcind < σcper
∴Design is safe

τ= p×dm÷2×tan(α+ϕ)
Assume (μ=0.15)
ϕ=1÷tan (μ)
ϕ=8.53.
α=1÷tan(pitch÷πdm)
α=1÷tan(3÷π×14.5)
α=3.76.
τ=12×103×14.5÷2×tan(3.76+8.53)
τ=18.95×103 N.mm

To check σs

τ=π÷16×σs×dc3
18.95 ×103=π÷16 ×σs ×133
σs=43.92mpa
σsind < σsper
Design is safe

Maximum principal stress and maximum shear stress

$\sigma cmax=1\div2 \times (\sigma cind + \sqrt{\sigma c2ind + 4 \times \sigma s2ind})$
σcmax=1÷2 × (90.422 + 4 × 43.422)
σmax=107.87mpa
σcmax < σcper
Design is safe

σsmax= 1÷2 × (σc2ind + 4 × σs2ind)
σsmax=1÷2 × (90.422 + 4 × 43.422)
σsmax=62.67 mpa
σsmax < σsper
Design is safe

Fig.3 Actual set up of Machine

VI. CONCLUSION

We have successfully design and fabricated Friction Stir welding machine. A CAD model of the Friction Stir Welding machine is designed on the CREO PARAMETRIC 3.0. The calculations for design of lead screw is done in order to find out the diameter and pitch of the lead screw in order to give proper transverse feed during welding to increase the welding quality. The tool material is selected as mild steel with circular tool profile. The Aluminium AA6061 sheet is welded successfully by rotating the tool at a speed of 1440 rpm and high quality welding is obtained.

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