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Design and Fabrication of Fixture for Friction stir welding in Conventional lathe

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ABSTRACT

Lathe operations tend to involve straight and cross cuts that produce lots of chips and involve varying force. Due to the vibration of the machine, positive stops are preferred over friction for securing the work piece. In this project we are aiming to make the fixture for complicated components and machining is done by using this fixture to improve the production standards. Fixture is used to hold irregular shaped work pieces in all type of machining operations. Fixture is required in various industries according to their applications. A new type of Fixtures is designed to replace the compound rest in lathe for the process of Friction Stir Welding [FSW]. Both the lathe operation as well as welding operation can be done in a single machine. Friction stir Welding is the type of welding used as a solid-state joining process for materials that is different alloys of aluminum, magnesium etc. and also for hard materials like steels because it deflects the common problems obtained in conventional welding processes. FSW of aluminum is becoming an increasingly mature technology with numerous commercial applications.

1. INTRODUCTION

Friction Stir Welding (FSW) is a solid-state joining process and is used for applications where the original metal characteristics must remain unchanged as far as possible. Aluminum alloy are important for the fabrication of components and structure which require high strength, low weight or electric current carrying capabilities to meet their service requirement. Among all aluminum alloys, AA 6061 alloy plays major role in the aerospace industry in magnesium and silicon are the principal alloying elements. The present work an attempt is made to study the feasibility of joining AA 6061-T6 series aluminum alloy by friction stir welding (FSW). Friction Stir Welding was invented and patented by The Welding Institute in 1991. The process uses a spinning, non-consumable tool, similar to a taper reamer, to generate frictional heat in the work piece. By pressing this tool into contact with a seam to be welded, the base metal heats up and once it reaches about 80% of its melting point it becomes soft and deforms easily. By keeping the tool rotating and moving it along the seam to be joined, the softened material is literally stirred together forming a weld without melting. These welds require low energy input and are without the use of filler materials and distortion. Initially developed for non-ferrous materials such as aluminum, by using suitable tool materials the use of the process has been extended to harder and higher melting point materials such as steels titanium alloys and copper. Since its conception in 1991 there have been considerable advances in process technology and there are now over 135 licensees of the process and over 1500 subsidiary patents have been filed.

2. BASE METAL ALUMINIUM ALLOYS

2.1 Introduction to aluminum alloy 6061-T6

The 6061 alloy of aluminum is primarily composed of magnesium and silicon. This gives 6061 aluminum alloy superior welding ability over other alloys of aluminum, which are tradionally difficult to weld because of their chemical makeup and lack of conductivity.

Fig 1. Aluminum alloy 6061-T6 series

some other elements of 6061 aluminum alloy include small amounts of iron, copper, manganese, magnesium, chromium, zinc and titanium

Temper designations

T6-solution heat-treated and artificially aged,

- construction, including small utility boats
- 6061 is used in automotive parts , such as wheel spacers

- 6061 is used in the manufacture of aluminum cans for the packaging of foodstuffs and beverages.
- 6061 is used in SCUBA tanks (post 1995)
- 6061 was the material used for the pioneer plaques

2.2 AA 6061-T6 MATERIAL PROPERTIES

ALUMINIUM ALLOY 6061-T6

Table1. Chemical composition of AA 6061(%)

Mg	Si	Fe	Cu	Cr	Mn	Zn	Ti	Al
0.9	0.62	0.33	0.28	0.1	0.06	0.02	0.02	Bal

Table.2. Mechanical properties of AA 6061

Yield strength (MPa)	Ultimate strength (MPa)	Elongation (%)	Reduction in cross sectional area (%)	Hardness(VHN)
302	334	18	12.24	105

Table.3. Physical properties of AA6061.

Physical Property	Density(g/cm3)	Melting point (˚C)	Modulus of elasticity (GPa)	Poison ratio
AA 6061	2.7	580	70-80	0.3

Reference: APPN journal of engineering and applied science

2.3 AA 6061-T6 APPLICATIONS

- 6061 is used for yacht construction, including small utility boats.
- 6061 is used in automotive parts, such as wheel spacers.
- 6061 is used in the manufacture of aluminium cans for the packaging of foodstuffs and beverages.
- 6061 is used in SCUBA tanks (post 1995)
- 6061 was the material used for the Pioneer plaques.
- 6061-T6 is commonly used in the construction of bicycle frames and components.
- 6061-T6 is used in many fly fishing reels.

3. TOOL SELECTION

The simple pin-shaped, non-profiled tool creates frictional heat and is very useful if enough down force can be applied. The need to generate more frictional heat and break the oxide-layer more effectively has been a driving force in tool development for light-metals. Tools for steels To apply FSW in steel or other high-temperature materials, the difficulty is mainly associated with finding proper tool material; a material that can withstand the high temperatures that are experienced during the process. Resistance to wear (durability) is one important aspect, especially as many of the intended applications are considered critical; hence there can be no traces of the tool left in the seam.

Fig 2. Tool Material

3.1 TOOL MATERIAL

A friction stir welding tool is obviously a critical component to the success of the process. The tool typically consists of a rotating round shoulder and a threaded cylindrical pin that heats the workpiece, mostly by friction, and moves the softened alloy around it to form the joint. Since there is no bulk melting of the workpiece, the common problems of fusion welding such as the solidification and liquation cracking, porosity and the loss of volatile alloying elements are avoided in FSW.

HSS (M2) MATERIAL

"HSS" is the standard material used for all ICS HSS cutting tools.M2 has good red-hardness and retains its cutting edge longer than other general purpose HSS, not as shock resistant or as flexible as other HSS grades with less tungsten. Generally favoured for high production machine works.

3.2 CHEMICAL COMPOSITION OF M2 (%)

- Carbon=0.85
- Tungsten=6.00
- Molybdenum=5.00
- Chromium=4.00
- Vanadium=1.9
- Hardness=63-65

3.3 TOOL DIMENSION

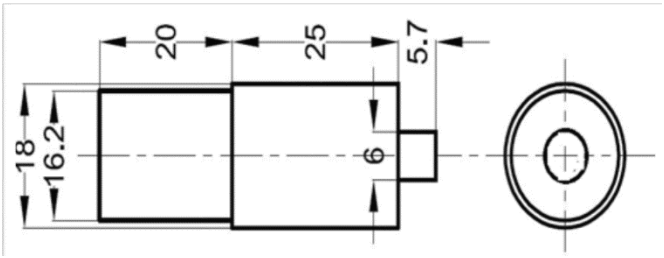


Fig 3. Tool profile

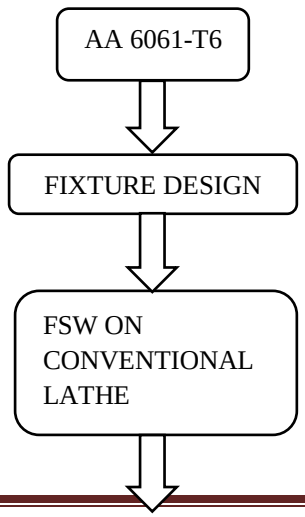
- Shoulder Diameter = 18mm
- Pin Diameter = 6mm
- Pin Length = 5.7mm

IMAGE OF HIGH SPEED STEEL (M2)

Fig 4.Tool Image

4. EXPERIMENTAL WORK

4.1 WORK PLAN



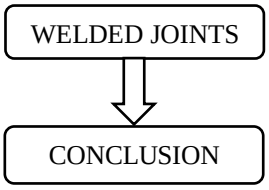


Fig 5.Work plan

5. WELDING FIXTURE

A fixture is a device used for holding the work piece during machining operations or during welding process. It does not have provision to guide the tool as that of a jig. But it is always fastened to a machine table in a fixed position.

5.1. 2D VIEW OF FIXTURE DESIGN

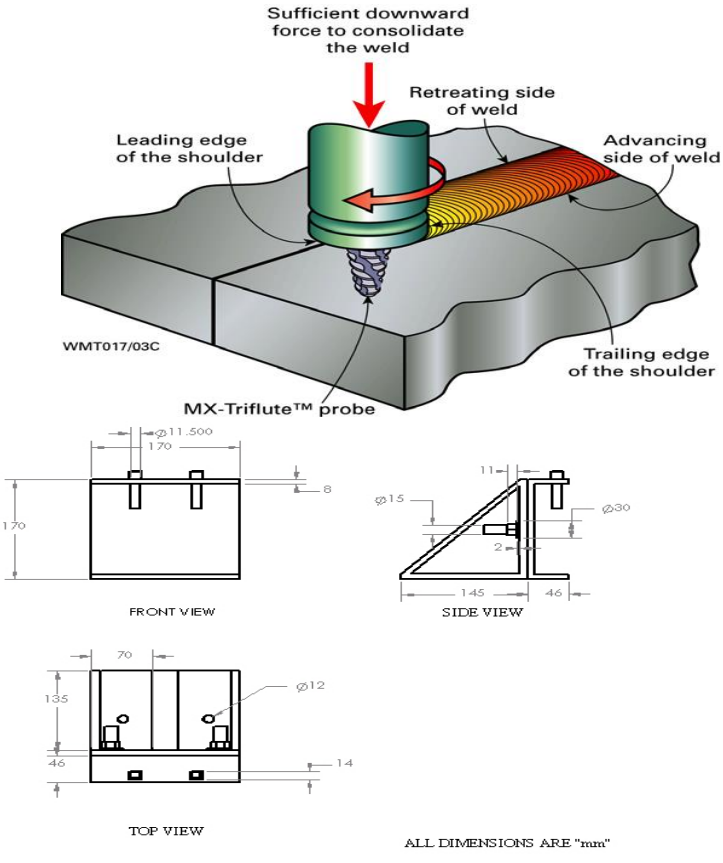


Fig 6.2D View of Fixture Design

5.2. 3D VIEW OF FIXTURE DESIGN

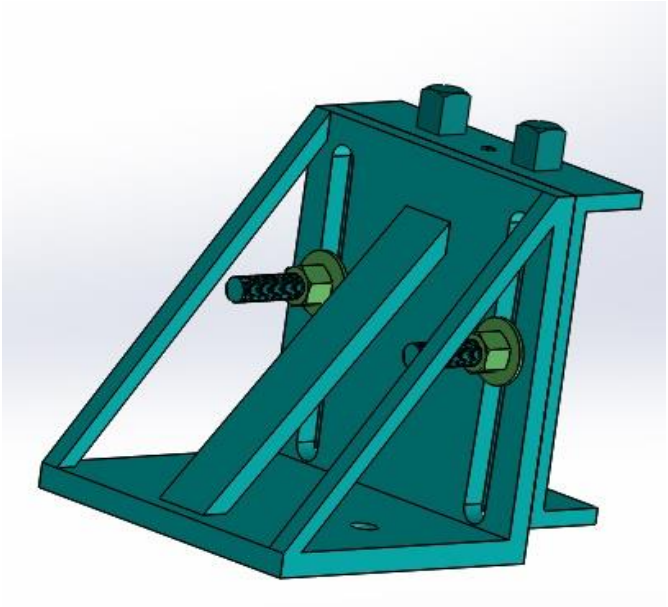


Fig 7.3D View of Fixture Design

6. WORKING PRINCIPLE

In FSW, a cylindrical-shouldered tool, with a profiled threaded / unthreaded probe (nib or pin) is rotated at a constant speed and fed at a constant traverse rate into the joint line between two pieces of sheet or plate material, which are butted together. The parts have to be clamped rigidly onto a backing bar in a manner that prevents the abutting joint faces from being forced apart. The length of the nib is slightly less than the weld depth required and the tool shoulder should be in intimate contact with the work surface. The nib is then moved against the work.

Fig 8. Friction Stir welding process

Frictional heat is generated between the wear-resistant welding tool shoulder and nib, and the material of the work pieces. This heat, along with the heat generated by the mechanical mixing process and the adiabatic heat within the material, cause the stirred materials to soften without reaching the melting point, allowing the traversing of the tool along the weld line in a plasticized tubular shaft of metal.

As the pin is moved in the direction of welding, the leading face of the pin, assisted by a special pin profile, forces plasticized material to the back of the pin while applying a substantial forging force to consolidate the weld metal.

6.1. EXPERIMENTAL SETUP ON LATHE

Friction stir weld of 6061-T6 aluminium alloy in butt joint configuration were produced on 100mm x 50mm 6mm thick sheets. Two different shoulder diameter tools-18 and 22 mm with a constant tool pin diameter of 6 mm were used to produce the welds. The rotational speed of 720, 850 and 900 rpm; and feed rates at 28, 40 and 52 mm/min were chosen to represent low, medium and high setting respectively. Two aluminium plates of size50x100x6 were perfectly clamped in a fixture with backup plate on shown in fig.9.

Fig 9.FSW setup on lathe machine

PHOTOGRAPHY

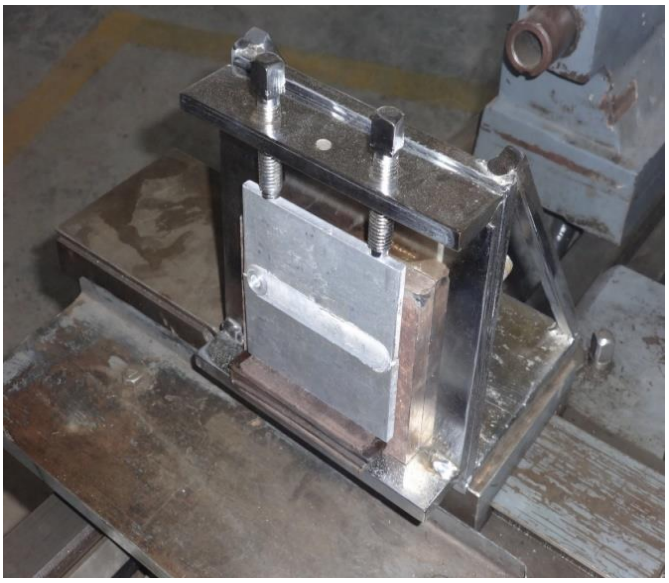


Fig 10. Welding Fixture Design

7. CONCLUSION

Joining of dissimilar Aluminum alloys 6061-T6 was performed using Friction Stir Welding on Conventional lathe. In this project we are actually done the fabrication of the fixture and manufactured the fixture. The fixture is used for friction stir welding (FSW) in lathe machine. And the fixture is used for industrial purpose. And by using this fixture we improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labor by simplifying how workpieces are mounted, and increasing conformity across a production run. Some modification in design of welding fixture and selection of welding parameters needed to get better result.

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