APPENDIX

Appendix 1

The details of the fixture and its parts are shown below.

Table A1.1: Bill of material used for fixture

SR. NO.	COMPONENT DETAILS	MATERIAL SELECTED	QUANTITY
1	BASE PLATE	FERRITIC STEEL	1
2	UPPER PLATE	FERRITIC STEEL	2
3	STOPPER	FERRITIC STEEL	1
4	VARIABLE clamp piece	MILD STEEL	2
5	L-CLAMP	FERRITIC STEEL	1
6	RIGHT ANGLED PIECE 1 & 2	MILD STEEL	4
7	BOLTS (different sizes)	HARDENED	25

A1.1 DETAILS OF FIXTURE DRAWINGS:

1. Base plate: It will provide a support to the plates to be joined and other accessories like L-clamp, variable clamp and upper plates.

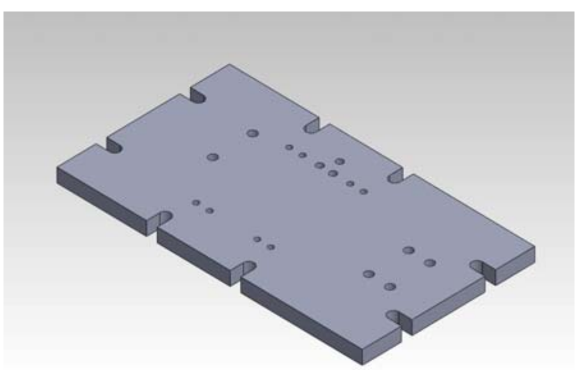


Fig A1.1 (A) Isometric view of base plate

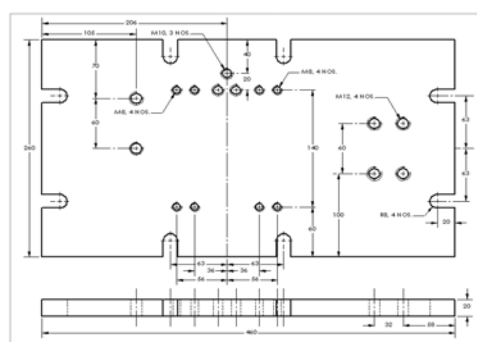


Fig A1.1 (B) 2D view of Backing plate

2. Top clamping plate

These plates will provide clamping from above. There are in all two plates and each contains four holes of 8mm diameter and three holes with threads of 10mm diameter. Grub screw to be used in these plates will provide additional clamping.

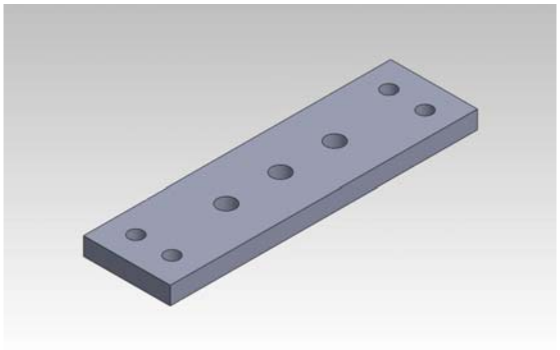


Fig A1.2 (A) Isometric view of Upper plate

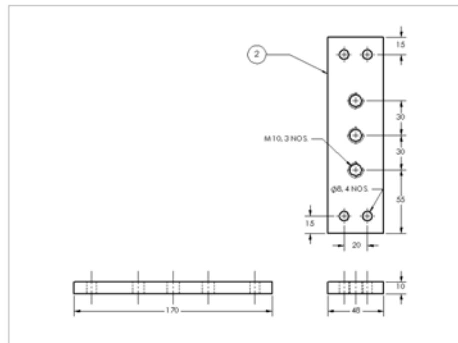


Fig A1.2 (B) 2D view of Upper plates

3. Stopper

The stopper is used to restrict the movement of the plates longitudinally under the application of tool. Stopper is made of ferrite steel (430).

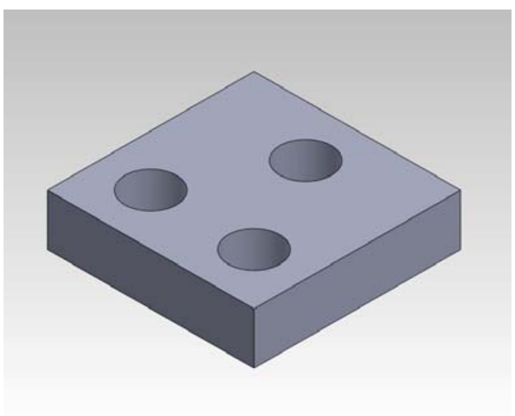


Fig A1.3 (A) Isometric view of stopper

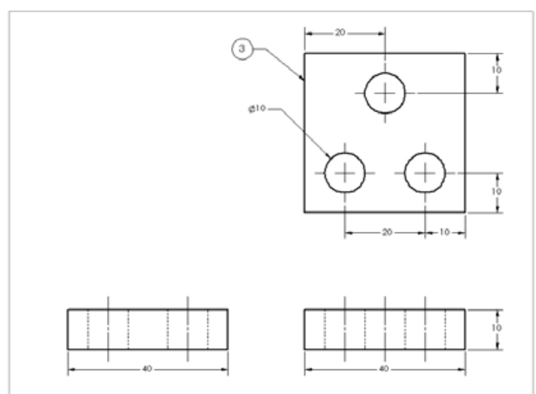


Fig A1.3 (B) 2D view of stopper

4. Variable clamps piece

These variable clamps are used to vary the gap between the two plates to be joined with the help of the right angled pieces. There are total two variable clamps and are fabricated from mild steel

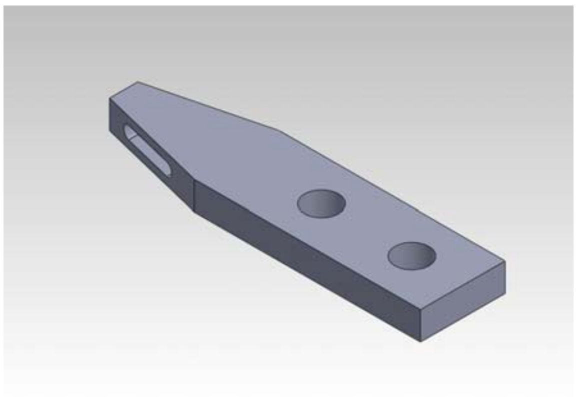


Fig A1.4 (A) Isometric view of Variable clamp

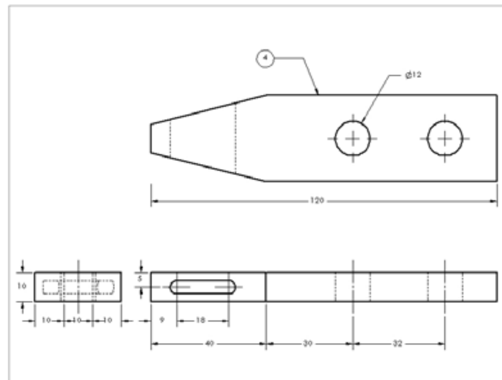


Fig A1.4 (B) 2D view of Variable clamp

5. L-clamp

L-clamp is used as a side clamp to restrict the side movements of plates. It is also made of ferrite steel (430).

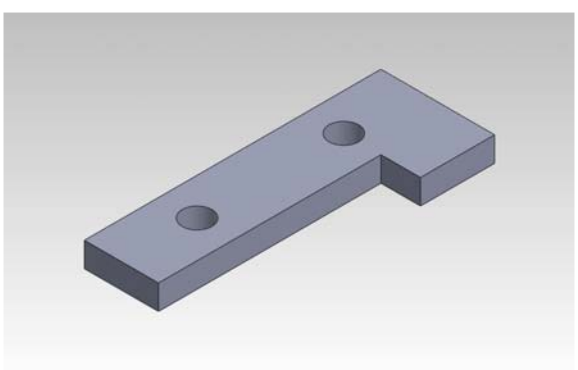


Figure A1.5 (A) Isometric view of L-clamp

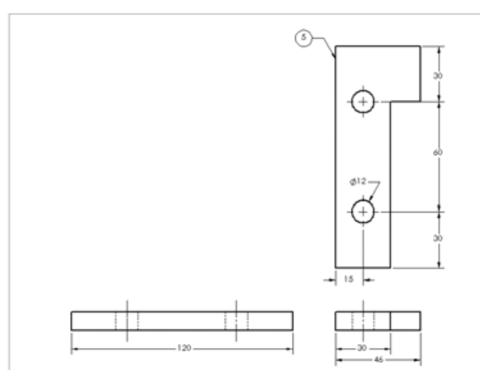


Figure A1.5 (B) 2D view of L-clamp

6. Right angle piece:

This right angle piece has a hole with threads and there are two pieces with such geometry. The angle between the inclined length and the base is 75 degree.

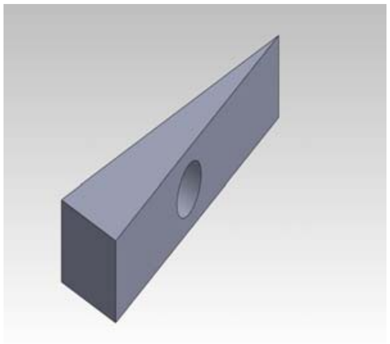


Figure A1.6 (A) Isometric view of right angled piece

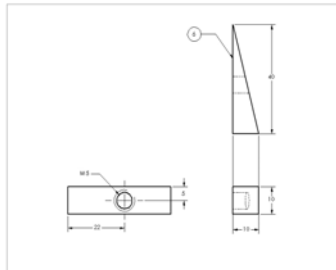


Figure A1.6 (B) 2D view of right angled piece 1

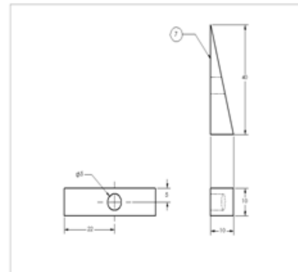
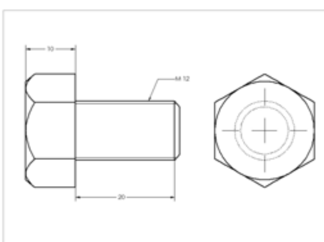


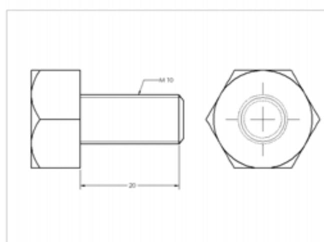
Figure A1.6 (C) 2D view of right angled piece 2

These pieces will be attached to the variable clamp, in which one will act as nut (figureA1.6 B). The right angle piece-2 consists of hole without any threads (figure A1.6 C). There are two pieces of this geometry. That is a combination of one with the thread and one with only hole will used with each variable clamp.

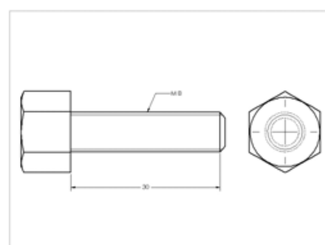
DIFFERENT TYPES OF BOLTS:



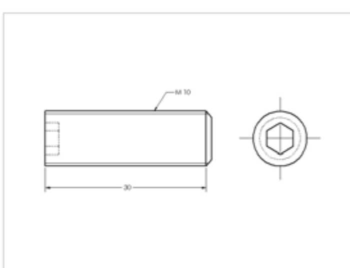
1. M12 Hexagonal Headed Bolt for part 4 and 5 (Qty: 6 nos.)



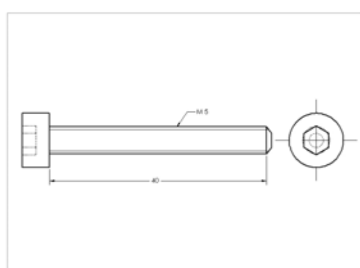
2. M10 Hexagonal Headed Bolt for part 3 (Qty: 3 nos.)



3. M8 Hexagonal Headed Bolt for part 2 (Qty: 8 nos.)



4. M10 LN Grub Screw for part 2 (Qty: 6 nos.)

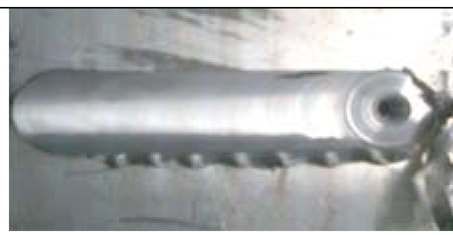


5. M5 LN Headed Bolt for part 6 (Qty: 2 nos.)

Appendix 1.1

Code no.	Image	Process parameters
E1A		Speed N = 545 rpm, Feed S = 50 mm/min

Fig A1.7: Top surface of weld sample prepared with hexagonal pin tool - Welding parallel to rolling direction

Code no.	Image	Process parameters
E1		Speed N = 545 rpm Feed S = 50 mm/min
E2		Speed N = 545 rpm Feed S = 78 mm/min
E3		Speed N = 545 rpm Feed S = 120 mm/min

E4		Speed N = 765 rpm Feed S = 50 mm/min
E5		Speed N = 765 rpm Feed S = 78 mm/min
E6		Speed N = 765 rpm Feed S = 120 mm/min
E7		Speed N = 1070 rpm Feed S = 50mm/min
E8		Speed N = 1070 rpm Feed S = 78 mm/min
E9		Speed N = 1070 rpm Feed S = 120mm/min

Fig 4.2: Top surface of weld sample prepared with hexagonal pin, concave shoulder tool at different tool rotation speed & welding speed (Welding across the rolling direction)

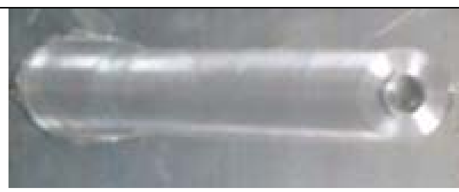
Code no.	Image	Process parameters
E10		Speed N = 545 rpm Feed S = 78 mm/min
E11		Speed N = 765 rpm Feed S = 78mm/min
E12		Speed N = 1070 rpm Feed S = 120 mm/min

Fig 4.3: Top surface of weld sample prepared with square pin, flat shoulder tool profile at different tool rotation speed & welding speed (Welding across the rolling direction)

Appendix 2

Tool pin and shoulder combinations (refer Table 3.7)

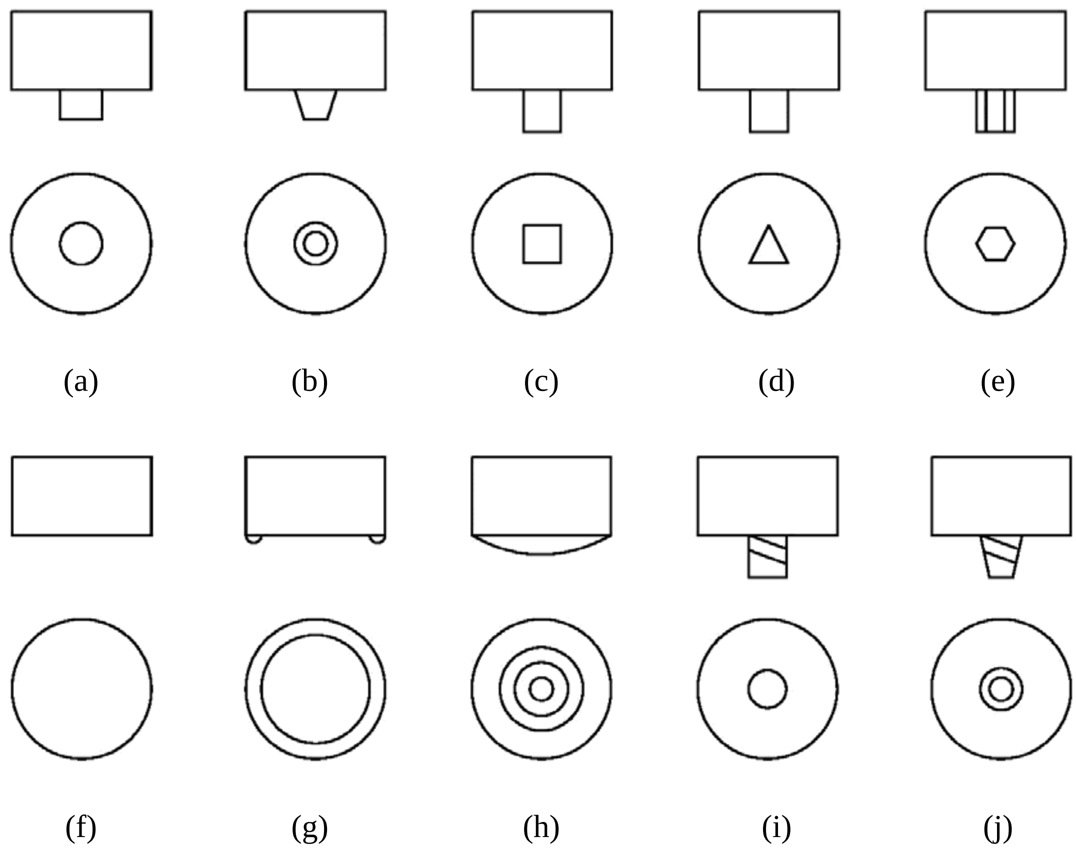


Figure A2: Tool pin and shoulder combinations

Appendix 3

Publications

LIST OF PAPERS PUBLISHED RELATED TO PHD WORK

Sr. No.	Title	Detail of the Journal/ Conference proceeding	Authors
1.	Effect of process parameters on corrosion resistance of AA 6101 T6 Al alloys welded by Friction stir welding	International Journal of Advance Engineering and Research Development, Vol. 4, Issue 9, September 2017, 580-586	**L. V. Kamble** S. N. Soman P. K. Brahmankar
2.	Understanding the Fixture Design for friction stir welding research experiments	Elsevier - Materials Today Proceedings, Vol. 4, Issue 2PA, April 2017, 1277-1284, ISSN 2214-7853	**L. V. Kamble** S. N. Soman P. K. Brahmankar
3.	Study of Pitting Corrosion Behavior of FSW weldments of AA6101- T6 Aluminium Alloy	Int. Journal of Engineering Research and Applications, Vol. 5, Issue 9 (Part -1) September 2015, 38-44. ISSN 2248-9622	**L. V. Kamble** S. N. Soman P. K. Brahmankar V. V. Mathane
4.	Effect of Tool Design and Process Variables on Mechanical Properties and Microstructure of AA6101-T6 Alloy Welded by Friction Stir Welding	IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2013, 30-35. ISSN(e) : 2278-1684, ISSN(p) : 2320–334X,	**L. V. Kamble** S. N. Soman P. K. Brahmankar

Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 4, Issue 9, September -2017

Effect of process parameters on corrosion resistance of AA 6101 T6 Al alloys welded by Friction stir welding

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Abstract - *Corrosion is always a limiting factor for deciding life of a material. The 6xxx series Al alloys are considered to have better corrosion resistance compare to other grades. Even then welded samples has some effect of pitting in salt bath. In present paper the welding of plates was carried out using a well-known solid state welding process called as Friction Stir Welding (FSW). The process is widely used for joining Al alloys in marine, aerospace, automobile and railway industries. The welding was carried out on conventional milling machine with different tool rotational speeds and traversing speeds. The corrosion tests of base metal and welded samples were carried out in 3.5% NaCl solution at room temperature using cyclic polarization measurement. The pitting effect at different zones like heat affected zone (HAZ) and thermo mechanically affected zone (TMAZ) was studied and results were presented graphically. The impact of process parameters was observed on corrosion resistance after FS welding than base metal. The material characterization of welded samples was also done.*

Keywords - *pitting corrosion, friction stir welding, cyclic polarization, TMAZ, HAZ.*

I. Introduction

Friction stir welding (FSW), being a popular process adopted by fabrication industries, was a development of The Welding Institute, UK [1]. The process is advantageous and problems like porosity, hot cracking in case of fusion welding processes (GTAW or GMAW) can be eliminated [2].

In FSW process, a cylindrical rotating tool is plunged into the abutting edges of the work-piece to be joined, whereby the shoulder has intimate contact with the top surface of the material while the pin is fully penetrated into the material [3], as shown in Figure 1.

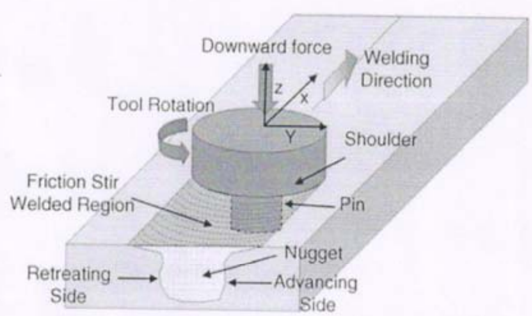

Figure 1. Schematic illustration of FSW process [3]

Corrosion of any material is not acceptable and need to be studied properly. Generally, it has been found that the weld zones are more susceptible to corrosion than the parent metal. Friction stir (FS) welds of aluminium alloys such as 2219, 2195, 2024, 7075 and 6013 did not exhibit enhanced corrosion of the weld zones [4]. FS welds of aluminium alloys exhibit intergranular corrosion mainly located along the nugget's heat-affected zone (HAZ) and enhanced by the coarsening of the grain boundary precipitates. Coarse precipitates and wide precipitate-free zones promoted by the thermal excursion during the welding are correlated with the intergranular corrosion.

Jariyaboon et al. [5] studied the effect of welding parameters (rotation speed and travel speed) on the corrosion behavior of friction stir welds in the high strength aluminium alloy AA2024–T351. It was found that rotation speed plays a major role in controlling the location of corrosion attack. A comparison of the corrosion resistance of AA6060T5 and AA6082T6 joints made by Friction Stir Welding (FSW) and Metal Inert Gas (MIG), respectively, is reported by Stefano and Chiara [6]. Tests were conducted by putting the welded and polished samples in an acid salt solution.

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5th International Conference of Materials Processing and Characterization (ICMPC 2016)

Understanding the Fixture Design for friction stir welding research experiments

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[b](Metallurgical and Materials Engineering Department, The M. S. University of Baroda, India)
[c](Mechanical Engineering Department, Dr. Babasaheb Ambedkar Technological University, Lonere, India)

Abstract

Friction stir welding (FSW) process was developed in 1991 by The Welding Institute (TWI) to weld nonferrous metals especially Aluminium alloys. Later on the process could extend its viability for other non-ferrous metals like copper and brass and for welding of dissimilar material combinations and composites. The process is adapted and experiments were carried out in a piecemeal manner by numerous researchers, but till the date a thumb rule is not possible to be developed. Most of the researchers have done the research or investigations for variable parameters (e.g. spindle speed, tool feed etc.) and their effect on different properties, but for experimental purpose it is said that a rigid clamping is of utmost importance in the FSW.
The present paper will throw some light in the direction of systematic design, considering different requirements for design and fabrication of flexible fixture which will accommodate different thickness and size of substrate, and controlled gap in the abutting region, which ultimately will facilitate the researcher for successful FSW experiment.

Keywords: Friction Stir Welding, fixture, tool, restraining;

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E-mail address: lvkamble@yahoo.co.in

1. Introduction

Friction Stir Welding (FSW), the innovative and Eco-friendly technique of solid state welding being invented and patented by TWI(THE WELDING INSTITUTE), UK[1]. From the literature it is observed that there are different design parameters like pin diameter, pin profile, shoulder diameter, shoulder profile, ratio of shoulder to pin diameter; and process parameters- rotational speed, feed rate etc. has an effect on quality of weld. The flow of material depends on heat generated through friction between work and shoulder interface. But nowhere it is mentioned about specific material of fixture and its design parameters as shown below Fig 1.

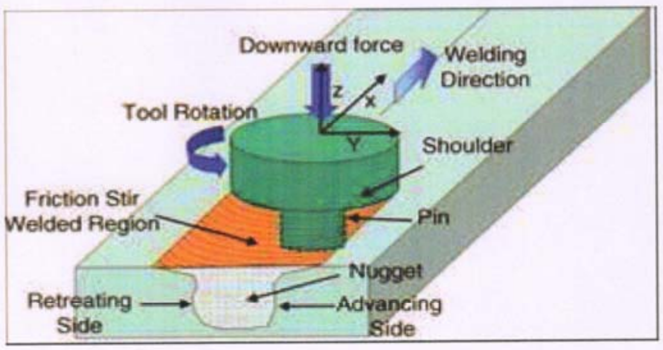

Fig.1. Schematic view of friction stir welding process [2]

Today research and development in FSW and associated technologies has mushroomed, with many companies, research institutes and universities investing heavily in the process and international conference series dedicated to it's study. TWI has issued more than 200 licenses for use of the process relating to FSW. The number of research papers has also grown exponentially.

In the beginning application of the friction stir welding process was limited to aluminium and its alloys, but this technique is widely used with various other types of metals nowadays. These progresses are the consequence of the new FSW tool development and a better process understanding. Nevertheless, one of the most important challenges is still the design of the tool (shoulder-pin system) to assure a good quality weld and to reduce the loads during the process. Consequently proper clamping system is equally important in experimental type research in FSW to get sound welds. Based on an extensive literature survey, a conceptual thinking is presented on FSW fixtures, covering the design and properties and effect of clamping method. The paper describes the typical fixture design and their characteristics. Finally, emerging fixture designs are reported.

2. Conceptual thinking

Only clamping the work piece is not the criteria in FSW, but restriction of movements and flexibility is more important. Many people have used milling vice (Fig.2) for clamping the object of small size. This type of vice will have size limitations as well as risk of accident. To do the research work one has to experiment as per guidelines laid by standards developed previously, and for that such vice will not serve the purpose. If we clamp using these vice then there are maximum chances of lifting of substrate from the center. So proper understanding is required to be developed for proper clamping of the work piece (plates) to be butt welded.

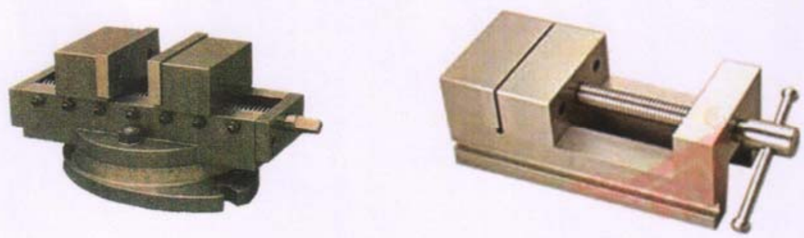

Fig.2. Different types of vice used in conventional machining process.

As suggested by TWI; the inventor, that (i) a rigid clamping is required to get sound weld and to avoid accident during friction stir welding, (ii) a backing plate is required, which will provide strong support sufficient enough to limit bending of substrate, (iii) horizontal and vertical plate movement should be restricted.

3. Design considerations

a) Base plate or backing plate should have sufficient thickness in comparison with thickness of the plates to be joined.
b) Material selected should have low thermal conductivity which will help in maintaining the temperature sufficiently high to facilitate plasticizing the material and its displacement.
c) Clamping from the top is required so that plates will not be lifted up from the position.
d) Horizontal movement in X and Y directions are required to be arrested.
e) Some provision is to be made to keep plates intact, so that gap in the butt region will be maintained zero or minimum. Otherwise joint will not have uniform welding.

Looking to the above requirements, it is observed that different methods are adopted to clamp the work-piece. People have tried to fulfil the requirements, but hardly any literature is available giving complete design understanding of fixture. One of the simplest way of clamping used by Prashant Prakash et.al. is shown in Fig.3.

Fig.3. Setting the Al plates in Universal Milling Machine [3]

Some of the researchers have adopted welding (Fig.4) in preparation of fixture. Clamping bar welded with base plate. In such cases, there are chances of distortion of fixture itself which will affect the accuracy of clamping and hence the quality of welding.

Fig.4. Fabrication of fixture using welding [4]

One of the different condition is observed in welding of Aluminium to mild steel clamping the plates on machine having vertical bed [5]. In such cases accurate clamping is a bit difficult and hence proper fixture is required to be fabricated and used for FSW.

A typical design of fixture clamping the plates at the edge (Fig. 5) is observed, which will restrict the horizontal movement in X-direction and vertical movement also, but this fixture will have size limitations, hence it is not a favourable design for larger width as per standards.

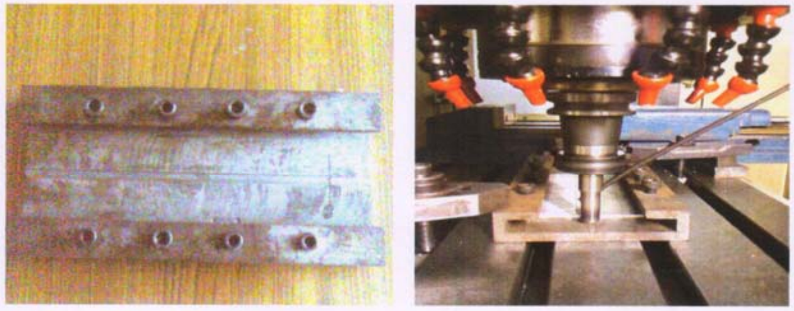

Fig.5. Fixture with horizontal movement restricted in X-direction and vertical clamping at edge [6]

Many of the researchers have used the workshop equipments for clamping the substrate plates Fig. 6. [7-10]

Fig.6. Clamping of plates using workshop clamps [7, 8]

Keeping in mind all above requirements and observations, we have developed a fixture which will serve the purpose and fulfil necessary design criteria to produce sound weld.

4. Different designing approaches

4.1. Design of fixture with single clamping from TOP

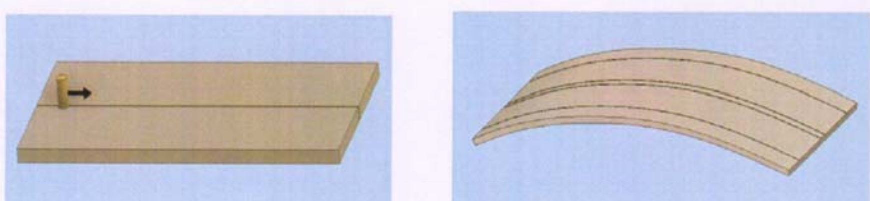

Fig.7. Plates without clamping (or clamping in the vice)

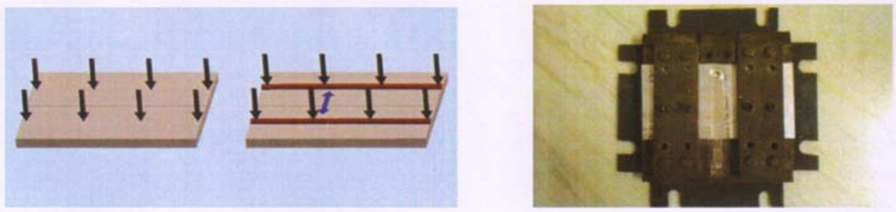

Fig.8. (a) Clamping the plates from top (b) Fixture fabricated and used for FSW

It is necessary to clamp plates from top to avoid lifting of or bending of plates (Fig.7) resulting from clamping done using conventional milling vice. So, it was thought to apply clamping force from the top, Fig. 8 (a) and (b).

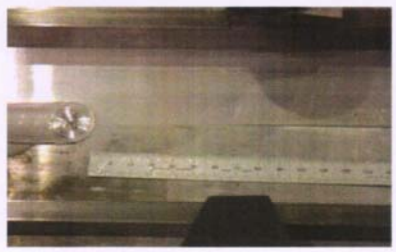

Fig.9. Opening of the Butt groove [11]

As in this design, the clamping force is applied from the upper side of plates only. There is a possibility of splitting of the plates (Fig.9) occur during the travel of tool pin along the length of the joint. Care is also required to be taken to keep minimum distance between the clamping bar restraining the vertical force in the direction of plate thickness. To avoid splitting of plates, a clamping from side is required perpendicular to the line of weld.

4.2. Design of fixture with SIDE CLAMPING

In this design we provide side clamps along with the upper plates. These side clamps can restrict the side movement of the plates to be welded, and no splitting will occur in butt region.

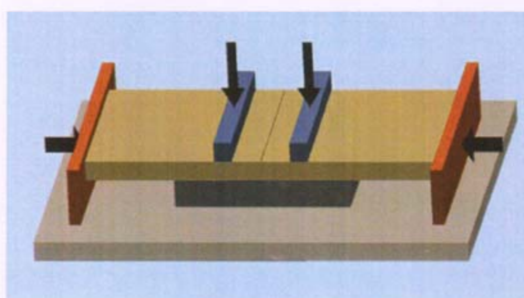

Fig.10. Clamping of plates from top and side with backing bar

4.3. Final design of Fixture with VARIABLE SIDE CLAMPING

We feel that the design shown in Fig.10 may be the correct design, but it also failed. And we forced to modify this design of fixture also. Because in this design there is still a chance of sliding to take place along the line of weld, when tool traverses, this sliding movement is also required to be arrested. Additionally we thought to control the abutting gap between the two plates to be joined as shown in Fig.11, 12. This will facilitate the researcher to consider this gap as one of the variable and its effect on weld properties will be studied further. The setup and welded sample is shown in Fig. 13 (a) and (b).

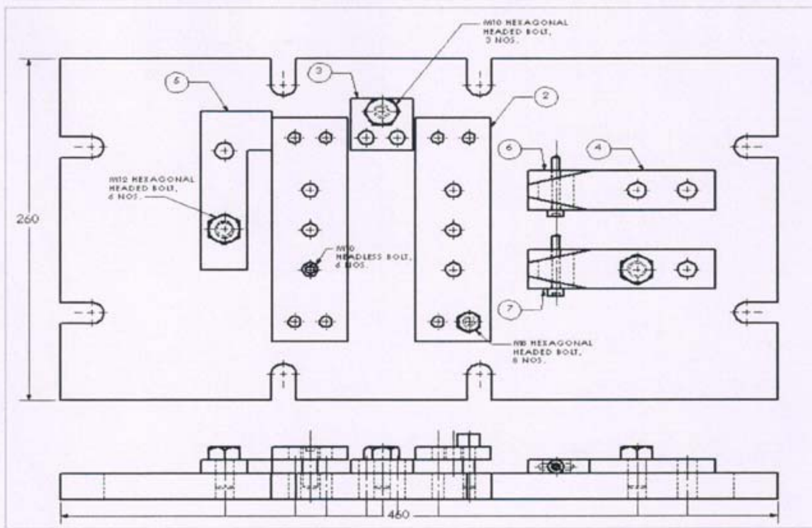

Fig.11. 2-D view of Fixture assembly

The material selected in fabrication of the fixture is carbon steel. One can use other grades of steel also depending on type of material to be joined and thickness of plates.

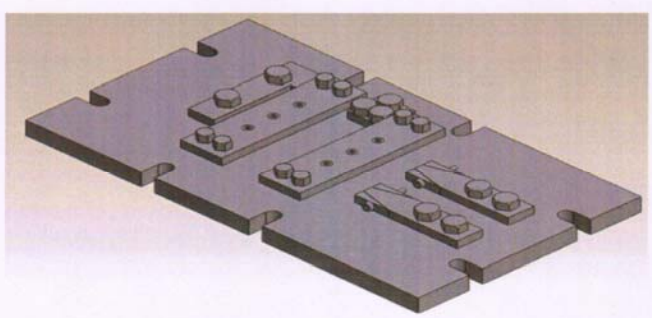

Fig.12. Isometric view of complete fixture assembly

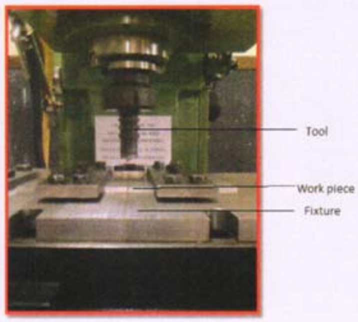

Fig. 13. (a) Experimental set up with variable type fixture used for FSW (b) Sample of plates welded by FSW

5. Conclusion

The fixture so designed was used to friction stir weld AA 6101 T6 aluminium alloys over 4mm to 10mm thickness successfully. The welded samples were tested for mechanical properties as well as microstructure. Some of the key point of fixture are-

- For the prevention of vertical distortion, the restraint which used the flat bar is effective.
- The restraint in the direction of plate thickness is inadequate.
- Welding methodology adopted in fabrication of fixture will result into inaccurate clamping due to distortion in the fixture itself, and hence quality of weld will be affected.
- A variable type of fixture with appropriate dimension is successfully designed and fabricated.
- Assembly parts were manufactured from carbon steel on the basis of their merits, retaining the sufficient heat for friction stir welding.
- Selection of above material leads to cost saving on manufacturing.
- Versatile design leads to efficient supporting, holding, clamping and arresting the movement of the plates to be joined and hence resulting into quality welds.

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RESEARCH ARTICLE OPEN ACCESS

Study of Pitting Corrosion Behavior of FSW weldments of AA6101- T6 Aluminium Alloy

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ABSTRACT
Friction Stir Welding (FSW) is a promising solid state joining process widely used generally for Al alloys, especially in aerospace, marine and automobile applications. In present work, the microstructure and corrosion behavior of friction stir welded AA6101 T6 Al alloy is studied. The friction stir welding was carried using vertical milling machine with different tool rotational speeds and welding speeds. The microstructure at weld nugget or stir zone (SN), thermo-mechanically affected zone (TMAZ), heat affected zone (HAZ) and base metal were observed using optical microscopy. The corrosion tests of base alloy and welded joints were carried out in 3.5% NaCl solution at temperature of 30° C. Corrosion rate and emf were determined using cyclic polarization measurement.
Key words - cyclic polarization, friction stir welding, microstructure, nugget, TMAZ.

I. Introduction

The FSW process is recently applicable for welding of aluminium and magnesium alloys as well as other non-ferrous and ferrous materials as well as composites and dissimilar materials [1, 2]. Welding of heat treatable AA6xxx Al alloy by FSW [3] gives better quality weld compared to other fusion welding processes. Since there is no direct melting involved, the control needed in fusion welding (to avoid phenomenon like solidification and porosity, loss of volatile solutes) can be avoided in this process. The solid state joining has led to attempt FSW for a wide range of alloys [4-6]. Recently aluminium alloys are used in automotive, shipbuilding, aircraft and railway industries, because they are light in weight, easy to machine and have relatively high strength properties. Age hardening heat treatment (T4 or T6) is used for increasing the strength in heat treated aluminium alloys (2xxx, 6xxx, and 7xxx series). In case of fusion welding processes such as TIG or MIG hot cracking observed. These problems can be eliminated in FSW [7]. Wert [2003][8] studied FSW of AA2024 welded with aluminium matrix composite and observed grain boundary liquation cracking on 2024 side of the weld. The 2024 T3 Al alloy is widely used as a structural material of aircraft. But it is susceptible to localized corrosion such as pitting. Generally temperature, humidity and salinity are the main factors considered for the accelerated test.

Venugopal et al [2004][9] studied microstructures and pitting corrosion properties of FSW of AA7075 Al alloy in 3.5%NaCl solution. Corrosion resistance of weldments at TMAZ is better than base metal. Friction stir welding of 7075 alloy resulted in fine recrystallized grains in a nugget which had been attributed from frictional heating and plastic flow of material. Cao and Kou [2005][10] studied FSW, GMAW of AA2219 alloy. GMAW was conducted to provide a benchmark for checking liquation in FSW of 2219 alloy. The microstructures of the resulting welds were examined by both optical microscope and SEM and were found that in GMAW of 2219 alloy Al2Cu particles act as in-situ micro sensors clearly in decanting the onset of liquation and show no evidence of induced liquation during FSW.

Ju Kang et al [11] investigated the surface corrosion behavior of AA2024-T3 Al alloy sheet welded by FSW by using in-situ observation method. From the SEM observation it is found that density and degree of pitting corrosion in the shoulder active zone was slightly larger compared to other regions on the top surface. The origin of the pitting corrosion was in the region between the δ -phase particles and the adjacent aluminium base.

The objective of the present work is to undertake the relationship between the microstructure in various zones and the corrosion behavior.

II. Friction stir welding process

In FSW, a rotating tool-shoulder & pin or pin with non rotating shoulder generate heat by friction and rotation and stir the faying surfaces to produce intermingling at atomic scale that result in sound welds.

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Effect of Tool Design and Process Variables on Mechanical Properties and Microstructure of AA6101-T6 Alloy Welded by Friction Stir Welding

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ABSTRACT: *Friction stir welding (FSW) has a potential for wide-spread applications. However, it is necessary to overcome some challenges for its wide-spread usage. Tool design and selection of process variables are critical issues in the usage of this process. This paper tackles the same issues for AA6101-T6 alloy (material used for bus bar conductor, requiring minimum loss of electrical conductivity and good mechanical properties). Two different tool pin geometries (square and hexagonal) and three different process variables, i.e. rotational speeds and welding speeds were selected for the experimental investigation. The welded samples were tested for mechanical properties as well as microstructure. It was observed that square pin profile gave better weld quality than the other profile. Besides, the electrical conductivity of the material was maintained up to 95% of the base metal after welding.*

Keyword: *FSW, Microstructure analysis, Mechanical properties, Electrical conductivity*

I. INTRODUCTION

Friction Stir Welding (FSW) technique was developed before two decades by 'The Welding Institute' (TWI), UK as a novel solid state joining process for Al alloys. Later, it has been developed and used for many other metals, composites and high melting alloys. Friction stir welding (Fig. 1) is a solid state joining process using a rotating tool moving along the joint interface, generating heat and resulting in a re-circulating plasticized material flow near the tool surface[1-3]. This plasticized material is subjected to extrusion by the tool probe rotational and linear movements leading to the formation of stir zone. This stir zone formation is affected by the material flow behavior under the action of rotating tool.

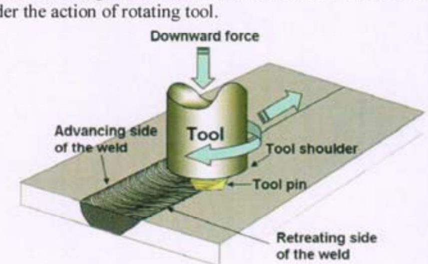

Fig. 1: Basics of Friction Stir Welding

The FSW process is applicable presently for welding of aluminium and magnesium alloys as well as other non-ferrous and ferrous materials like copper, steel, composites and dissimilar materials[4-5]. Welding of heat treatable AA6xxx Al alloy by FSW [6] gives better quality weld compared to other fusion welding process. Elangovan et al.[7] reported the effect of process parameters on mechanical properties of FS welded AA6061 aluminium alloy. They found that the tensile strength initially increased with an increase in tool rotational speed, welding speed and axial force. But the tensile strength decreased with further increase in these parameters after reaching a maximum value. They also studied the pin profile and rotational speed effects on stir zone of AA6061 and AA2219 aluminium alloy and investigated that square pin profile gives better results and less defects as compared to cylindrical, conical, threaded cylindrical or triangular profiles. Aluminum & aluminum alloy are difficult to weld, requiring weld pool shielding gas and specialized heat sources, require the oxide layer

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11 February 2016

To Whom it May Concern

In regard of L.V. Kamble, Mechanical Engineering Department, Faculty of Technology and Engineering, The M. S. University of Baroda, VADODARA -390001 Gujara, India

I am pleased to confirm that Mr L V Kamble from the above-named organisation has been invited to attend and present at the forthcoming 11th International Friction Stir Welding Symposium to be held at the Granta Centre, TWI Ltd, Granta Park, Great Abington, Cambridge CB21 6AL, UK on 17-20 May 2016.

Attendance at the Symposium will allow Mr Kamble the opportunity to meet with leading developers of Friction Stir Welding technology and equipment. Mr Kamble will be making a presentation on 'Design and Fabrication of Bobbin Tool for Friction Stir Butt Welding of Aluminium alloys - exploring the feasibility'.

The above-named person will be responsible for payment of the relevant symposium fee, together with his travel and accommodation expenses.

Please contact me immediately if any further information is required to facilitate the issue of an entry visa.

Yours faithfully

Becki Parratt

Becki Parratt
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Jonathan Martin <Jonathan.Martin@twi.co.uk>
To
'liladhar kamble'
CC
Becki Parratt
Jan 15 at 8:15 PM

ISFSW3

15 January 2016

Dear L.V.Kamble

Re: 11th International Symposium on Friction Stir Welding

Thank you very much for your abstracts submitted to the forthcoming 11th International Symposium on Friction Stir Welding.

We feel they would be of great interest to the attendees however we received an unexpectedly high number of quality abstracts, far too many to allow oral presentation of all of them. However, we are delighted to inform you that

Design and Fabrication of Bobbin Tool for Friction Stir Butt Welding of Aluminium alloys - exploring the feasibility

has been selected for **oral presentation**. (Please note, this acknowledgement is only being sent to the main author of the above paper.) In order to accommodate as many papers as possible, we have allocated 20 minutes per paper (15 minutes presentation + 5 minutes questions and answers). You are planned to present your paper during Technical Session 9 on 19 May 2016

Effect of welding parameters on mechanical properties and microstructure of AA 6101 T6 Al Alloy using Bobbin Tool Friction Stir Welding process

has been selected for poster presentation.

TWI Ltd is located about 10 miles (16km) from Cambridge City Centre which is a popular destination for visitors from all over the world. Hotels can therefore be expensive and in short supply. TWI Ltd has limited onsite accommodation available so the Symposium committee has agreed special rates with selected hotels. It is highly recommended that you book **accommodation** before the **end of February 2016**. Coaches will provide free return travel from the Menzies Hotel, the Holiday Inn Whittlesford and Cambridge railway station only to the Symposium venue (Granta Centre) and the social event.

Best regards

Jonathan Martin
Symposium Technical Director
jonathan.martin@twi.co.uk

Becki Parratt
Events Manager
becki.parratt@twi.co.uk

Date: May 28, 2016

Letter of Acceptance

To
Mr. L.V. Kamble
Mechanical Engineering Department
The M. S. University of Baroda
India

On behalf of the Organizing Committee, we are pleased to inform you that your paper entitled '**Development of Bobbin Tool for Friction Stir Butt Welding of Aluminium alloys – a feasibility study.**" has been accepted for Oral presentation at Mech Aero-2016. We welcome you to join us and share your knowledge and views in respective to the theme "**New Exploration in Mechanical & Aerospace Engineering**". This international conference will definitely offer you an unforgettable experience in exploring new opportunities".

4th International Conference and Exhibition on Mechanical & Aerospace Engineering is going to be held during **October 03-04, 2016 Orlando, USA.**

For more details about Mech Aero-2016-PS:
http://mechanical-aerospace.conferenceseries.com/
With Thanks,

Veronica Wilson

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Disclaimer: This invitation is to attend Mech Aero-2016 only.