International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 1 Jan 2022, pp: 232-235 www.ijaem.net ISSN: 2395-5252

Determination of Tensile Properties of Aluminium Alloy 6061

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Submitted: 01-01-2022 Revised: 05-01-2022 Accepted: 10-01-2022

ABSTRACT

Friction stir welding (FSW) is a solid state thermo mechanical joining process, it is a combination of extruding and forging process.This joining Technique welds by using a rotating and non-consumable welding tool to locally soften a work piece, through heat produced by friction and plastic work, thereby allowing the tool to stir the joint surfaces. In this welding process, a rotating welding tool is driven into the material at the interface of, for example, two adjoining plates, and then translated along the interface.

FSW offers ease of handling, precise external process control and high levels of repeatability, thus creating very homogenous welds. FSW is an ideal process for producing low cost and high performance joints. This joining technique is energy efficient, environment friendly, and versatile. In particular, it can be used to join high-strength aerospace aluminium alloys and other metallic alloys that are hard to weld by conventional fusion welding.

In this paper the evaluation of tensile properties of aluminium alloy 6061(AA 6061) welded joints such as tensile strength, yield strength, percentage of elongation, yield load, maximum load, maximum displacement, load-displacement curve and also studied.

Keywords : Friction stir welding , tensile strength, aluminium alloy

I. INTRODUCTION

Welding is a joining process coalescence of materials (typically metals or thermo plastics) by heating them to welding temperature, with or without the application of pressure or by the application of pressure alone, with or without use of filler material(1-2). There are many ways to make a weld and many different kinds of welds. Some processes cause sparks and others do not even require extra heat. Welding can be done anywhere. Outdoor or indoor, under water and in outer space. Nearly everything we use in our daily life is welded or made by equipment that is welded. Welders help to build metal products from coffeepots to Skyscrapers. They help to build space vehicles and millions of other products ranging from oil drilling rigs to automobiles. In construction, welders are virtually rebuilding the world, extending subways, building bridges, and helping to improve the environment by building pollution control devices(3-5). The use of welding is practically unlimited; there is no lack of variety of the type of work that is done. Variation was the use of inert gas with small amounts of oxygen that provided the spray-type arc transfer.

Welding is the most economical and efficient way to join metals permanently. It is the only way of joining two or more pieces of metal to make them act as a single piece. Welding is vital to our economy. It is often said that 50 % of the gross national product is related to welding in one way or the other. Welding ranks high among industrial processes and involves more sciences and variables than those involved in any other industrial process.Recent developments in friction welding which uses rotational speed and upset pressure to provide friction heat was developed in the Soviet Union. It is a specialized process and has applications only where a sufficient volume of similar parts is to be welded because of the initial expense for equipment and tooling(6-9). This process is called inertia welding. Laser welding is one of the newest processes. The laser was originally developed at the bell telephone laboratories as a communications device, as it possess tremendous concentration of energy in small space. It is proved to be a power full source. It has been used for cutting metals and non-metals. The laser is finding welding applications in automotive metal working operations.

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II. EXPERIMETAL METHODOLOGY

2.1 Friction Stir Welding

It is a solid-state joining process that involves joining of metals without fusion or filler materials. The frictional heat is produced from a rapidly rotating non-consumable high strength tool pin that extends from a cylindrical shoulder. The process is particularly applicable for aluminium alloys but can be extended to other products also. Plates, sheets and hollow pipes can be welded by this method. The process is also suitable for automation. The weld produced is of finer microstructure and superior in characteristics to that parent metal. Its cost effectiveness and ability to weld dissimilar metals makes it a commonly used welding process in recent times.In friction stir welding (FSW) a cylindrical, shouldered tool with a profiled probe is rotated and slowly plunged into the joint line between two pieces butted together. The parts have to be clamped onto a backing bar in a manner that prevents the abutting joint faces from being forced apart. Frictional heat is generated between the wear resistant welding tool and the material of the work pieces.

The working Principle of Friction Stir Welding is becoming an important joining process because it makes high quality welds for number of materials as compared to the conventional welding techniques. In FSW process, a non-consumable welding tool is used to generate the frictional heat between the tool and the work piece.This facilitates the tool movement along the joint line. As a result, the plasticized material is transformed from the leading edge of the tool to trailing side. Subsequently, it produces a high quality joint between the two plates by the translation movement of the work piece along with applied pressure of the tool.Terminology of friction stir welding process is shown in fig.1

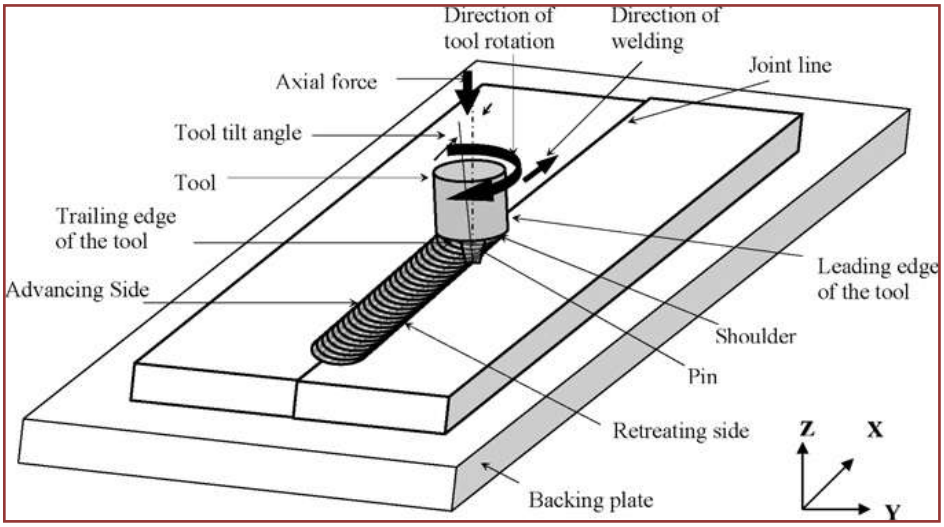

Fig.1Terminology of friction stir welding process

2.2 Tensile Test

It is one of the most widely used mechanical tests. It helps in determining (a) tensile properties such as tensile strength, yield point, ductility, yield strength.Two standard measurements of ductility are the percent elongation and the percent reduction of area when yielding is complete, the load starts to rise. The beginning of this yielding is the elastic limit. The metal is now in the plastic -state and the deformation of the test piece is permanent. The rate of straining will not need to be increased and by the time the maximum load is reached, the-gage length will have undergone a uniform extension if the material being tested has any ductility. If the material is brittle, the piece will not elongate but will break or fracture. The maximum load should be noted and the breaking load should also be noted. The maximum load is the ultimate strength of the metal. The test piece is then brought back together while still clamped into the machine, and the gauge length is re measured. The gage length of the test piece is then compared to the original gage length of the test -piece.

Universal testing machine,It has enlarged ends or shoulders for gripping. The important part of the specimen is the gage section. The cross-sectional area of the gage section is reduced

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relative to that of the remainder of the specimen so that deformation and failure will be localized in this region. The gage length is the region over which measurements are made and is cantered within the reduced section. The distances between the ends of the gage section and the shoulders should be great enough so that the larger ends do not constrain deformation within the gage section, and the gage length should be great relative to its diameter. Otherwise, the stress state will be more complex than simple tension. Tensile test specimens of aluminium alloy 6061(AA 6061) welded joints are prepared as per ASTM E8 standard and performed through UTM and determined tensile properties,such as tensile strength, yield strength, percentage of elongation, yield load, maximum load, maximum displacement, load-displacement curve and also studied. These are presented in Results and discussion.

III. RESULTS AND DISCUSSION

Tensile test specimen is prepared as per ASTM standard,the tests are performed inComputerised Universal Tensile Testing machine(UTM). The fig.2 shows tensile test specimen before the test fig.3 shows specimen after the test.

Fig.2. Tensile test specimenof weldedAA6061 before test

Fig.3. Tensile test specimen of weldedAA6061 after test

Results of tensile properties (Mechanical) are summarised in table.1

Table 1. Tensile properties(Mechanical) of welded Aluminium alloy 6061

Parameter	**AA6061 Tensile specimen**
Tensile strength	142.691 N/mm²
Yield strength	8340 N
Percentage of elongation	1.540 %
Yield stress	138.377 N/mm²
Yield load	8340N
Maximum load	8600 N
Maximum Displacement	1.95mm
Displacement at maximum force	1.85mm

The load and displacement curve as shown fig.4

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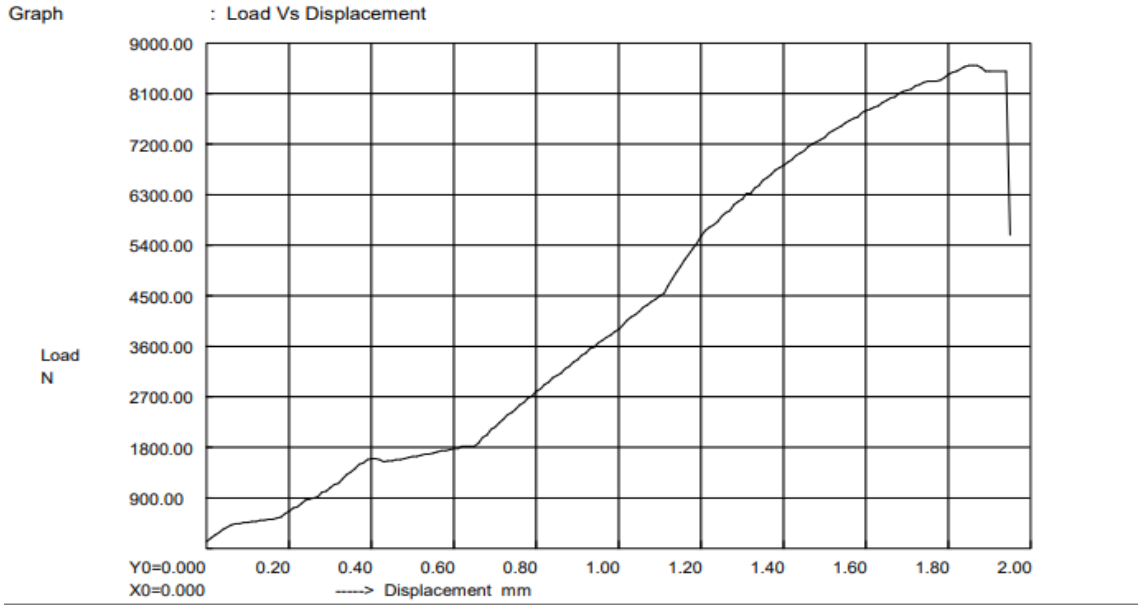

Fig.4 Load varies with displacement

From fig. 4, the load is increases with increasing of displacement upto certain level reached as shown in figure, after that it load decreases with constant displacement.

IV. CONCLUSIONS

The conclusions are drawn from present research work of FSW of Aluminium alloy 6061 as follows.

- Defect free welds has been welded.
- The weld line is perpendicular to loading direction
- Pin profile in FST is cylindrical shape.
- The tensile properties obtained for cylindrical pin profile Tensile strength142.691 N/mm², ductility level (elongation) of 1.54% , yield strength of 138.377 N/mm², yield load 8340N, maximum displacement 1.95mm and also displacement at maximum force 1.85mm.
- Load- displacement characteristics were obtained from load-displacement curve.

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