International Journal of Engineering, Science and Mathematics
Vol. 7 Issue4, April 2018(special issue NCIME)
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com Double-Blind
Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

DESIGN AND INVESTIGATION OF WELDING FIXTURE FOR DISTORTION RESTRAINTS OF ANGULAR WELDED JOINT

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Abstract. Welding fixtures are designed for the components which are difficult to weld in a normal way or without any holding unit, because fixtures have a direct influence on product quality, productivity and cost of a component to be manufactured in the industry. This paper investigates about the fixture design for restraining the angular distortions during butt welding within supplementary angles of joints by considering all the welding factors like easy access to its welding area, cycle time, and availability of space for fixture and materials are selected as per functional requirements and based on design by considering the technique of DFMA (Design For Manufacture And Assembly) by providing proper provisions for swiveling of the fixture accordingly to fix jobs for required angles of welds of high precisions. And conclusions on various aspects about the welded joints (i.e. distortion, material properties, strength, productivity, safety etc.,) were obtained by carrying the welding process with and without fixture.
Key words.Fixture, Butt weld, Distortions, Weld factors, Swiveling.

1. Introduction

Fixtures are rigid and sturdy mechanical devices which allow fast and precision machining and joining with reliable quality, interchange ability, and lead time reduction has direct impact upon welding quality, productivity and cost. Welding fixtures are used for holding different parts that have to be welded together. Distortion, residual stress and reduced strength in and around the weld are the major problems which lead to the failure of the components. This will affect the entire production rate and incurs the failure and replacing cost of the components.

This angular distortion is mainly due to non uniform transverse shrinkage along the depth of the welded plates. This problem can be reduced by providing initial angular distortion in the negative direction, if the magnitude of angular distortion is predictable. However the magnitude varies from materials to materials, hence a most economical fixture is needed to avoid such distortions.

This project aims at designing a most suitable fixture that avoids such a distortion during angular welded joints. Since we have many fixture of particular angles for joining bars and tubes, this design has multiple benefits of joining the jobs with complementary and supplementary angles of (0°-180°). This reduces the angular distortion leading to welding of grate accuracy.

2. Methodology

2.1. Selection of Welding Parameter

Following welding parameters are selected for welding mild steel tube of thickness 3mm.

Weld type	Oxy acetylene welding
Work dimension	25x25x150 mm
Weld speed	60cm/sec
Work and fixture material	Low carbon steel

2.1.1. Oxy acetylene welding. The oxy acetylene welding process joins metals by heating them with a fuel gas flame or flares with or without the application of pressure and with or without the use of filler metal. In this process fuel gas and oxygen are mixed in the proper proportions in a mixing chamber which may be part of the welding tip assembly. Molten metal from the plate edges and filler metal, if used, intermix in a common molten pool. Upon cooling, they coalesce to form a continuous piece. It is best suited for welding of thin sheet, tubes and small diameter pipe. It is also used for repair welding.

2.1.2. Tolerance selection. For engineering components tolerances should be provided approximately. However it is not necessary that all the dimensions shown in drawing be provided with tolerances. In facts a dimensions should carry a tolerance only when it is required. When tolerances for nominal sizes are not specified in engineering drawing, free measure tolerances are used. These are permissible deviation corresponding to the standards of accuracy normally attainable in workshop practice.

2.1.3. Selection of cutting process. Oxy fuel cutting is a process that uses fuel gases and oxygen to weld and cut metals. Pure oxygen along with fuel is used to increase the flame temperature to allow localized melting of the work piece material (e.g. steel) in a room environment.

2.1.4. Edge preparation.

Formula Used.

$$\text{Angle removed from work edge} = \frac{(180^\circ - \text{Angle of weld between the work})}{2}$$

For Example

A job is to be welded an angle to an angle of 120°, the angle of edge preparation is Obtained as,

$$\text{Angle to be removed from the work edge} = \frac{(180^\circ - 120^\circ)}{} = 30^\circ$$

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STEP -1

The job to be welded is aligned without edge preparation.

Figure 1 Prepared Edge.

STEP-2

Now, the edge preparation is done for required angle obtained from the above calculation.During the edge preparation we should confirm that the edge preparation is done inopposite side of the two plates to form a triangle while joining.

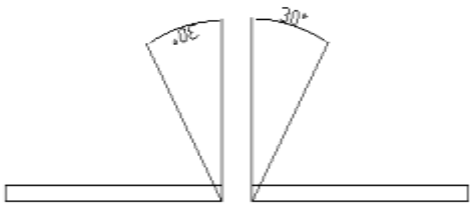

Figure 2 Angle to be formed.

STEP-3

Now the prepared edges are aligned together and the weld is carried.

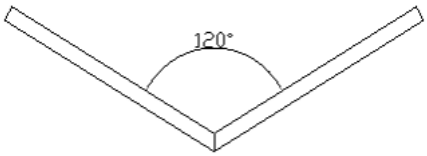

Figure 3 Welded work

WELDING SPECIFICATION

Welding specification	**Welding type**	**Time of weld in (mm)**	**Distortion degrees(°)**
Low carbon steel square tube (25x25x150)mm	Oxy acetylene welding	5	8
Low carbon steel square tube (25x25x150)mm	Oxy acetylene welding	3	2

2.1.5. Prototype preparation

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WELDING WITHOUT FIXTURE:In this step the work piece is prepared for the required angle and welded without the help of fixture or any supports and the distortion during welding is calculated and the heat transfer rate and deflection angle is calculated from the ANSYS software. Also the time elapsed during the welding without fixture is calculated with the help of a stop watch.

WELDING WITH FIXTURE:After the construction of the welding fixture the angle of the work to be welded is confirmed and the appropriate edge preparation is carried as follows as mentioned above in the fig(). The prepared edges are butted together for welding. After the edge preparation the work pieces to be welded is clamped to the welding fixture by adjusting the clamp pads and kept in well constrained position in order to minimize the welding distortion. Now the rotational clamp base is rotated to a required angel of weld and then bolted to its base. Now the welding operation is carried on the work piece. After the welding operation the work piece is measured for its angle and the distortion is calculated. The heat transfer rate and the deflection of the work piece are analyzed through ANSYS software. Also the time elapsed during the welding with fixture is calculated with a stop watch.

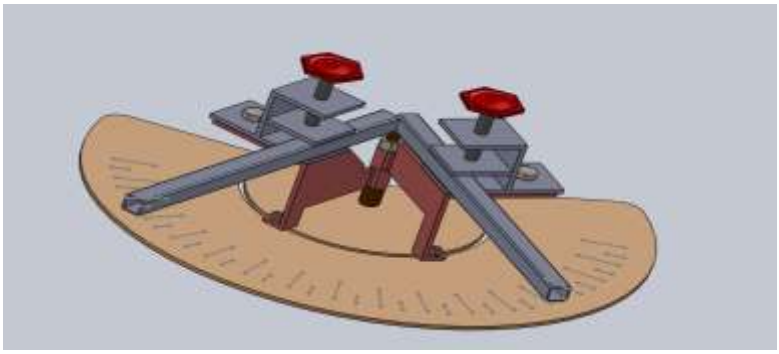

Figure 4 Fixture Model.

2.1.6 Detailing of the parts

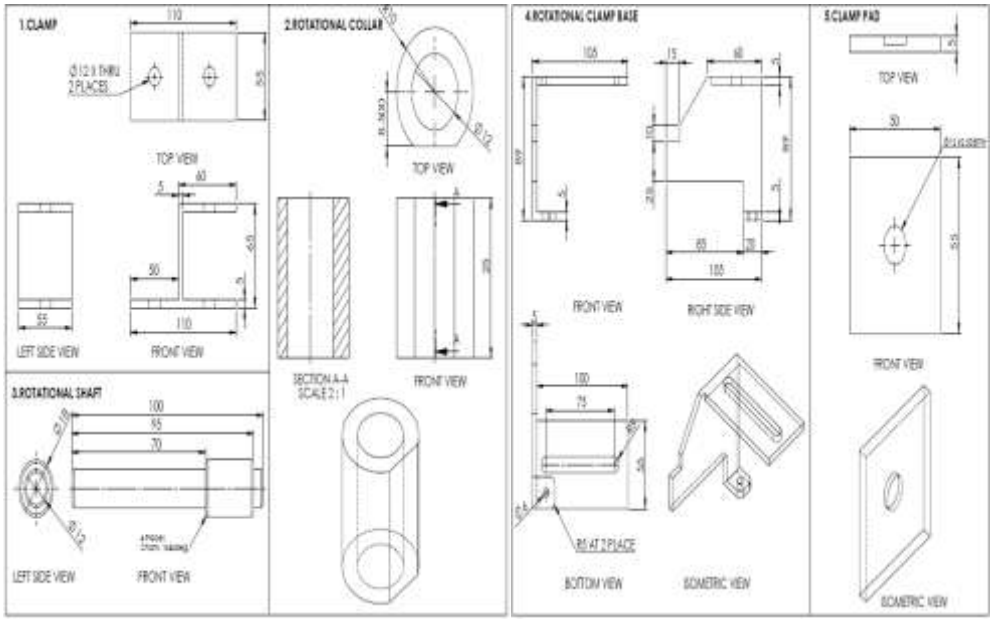

Figure 5 Drafted Parts.

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3. Analysis

- **Steady State Thermal Analysis of the work during welding.**

Steady state thermal analysis is used to find the temperature distribution in the work piece during the welding phenomenon. This will gives the detailed view of the temperature distribution on the work surface and the heat affected zone on the work.

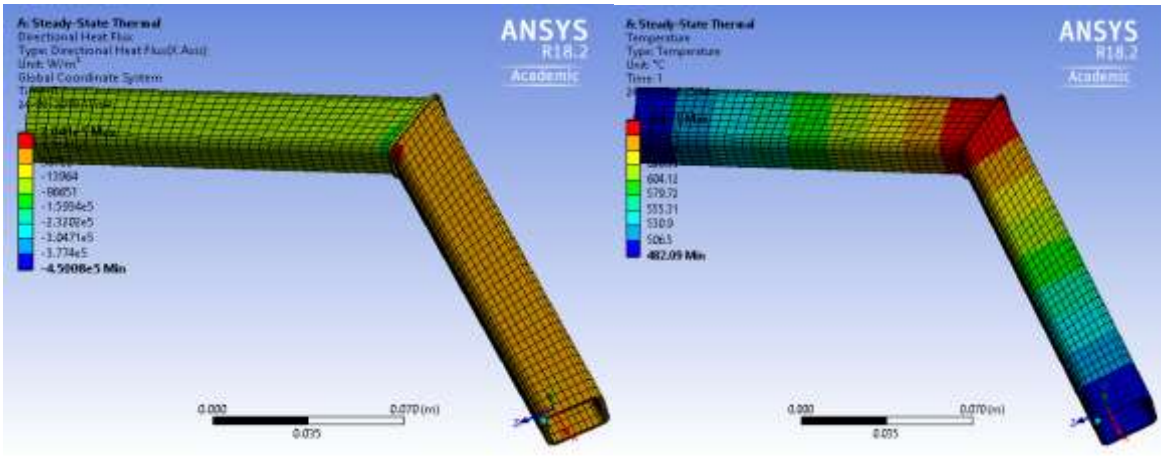

Figure 6 Temperature Distribution Diagram

This is done by importing the IGES file from the Cre-o software to the ANSYS bench work software and the following analysis are carried. The below analysis gives the state of breakage or the state of distortion of the work during the weld in the X & Y directions, which helps in detecting the weaker zone which is developed due to the residual stress during the welding process.

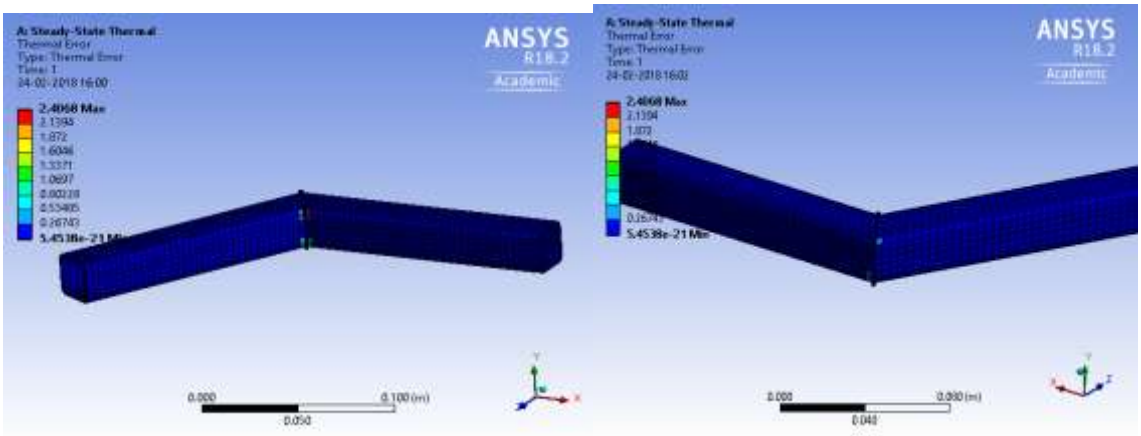

Figure 7 Weaker Zone Analysis.

4. Conclusion

This project overcomes the distortion problems in the welding process due to the residual stress developed during the welding. This also avoids the failure of the weld due to the distortion which in turns reduces the failure rates at Parts per Million. Also increased the safety of the welder and the welding environment and eliminates the second person for holding purposes. This ultimately reduces the distortion level and failure rates in welding leading to the increased production and reduced process time and increases the level of interchangeability.

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