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Design of a Welding Fixture and Analysis for the Footrest Stand Component

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***Abstract*-The main objective of this paper is the analysis of the component, which includes determination of stresses, strains and deformation in the component before and after the weldingdue to the application of the clamping load in a welding fixture. The analysis also includesTemperature distribution in the component during welding. This paper also deals with the various design aspects of a fixture for welding process. Stress calculation is necessary because high residual stresses may promote brittle fractures, fatigue in regions near the weld. The finite element method has been used to perform the analysis.The fixture design is carried out by using Solidworks modeling software and the components are analyzed by finite element method (FEM) using ANSYS software.**

Key words: Welding fixture; Solidworks; FEM; Ansys

I. INTRODUCTION

The fixture is a special tool for holding and supporting a work piece in proper position during a manufacturing operation. For supporting and clamping the work piece, device is provided [1].In most of manufacturing processes, the component should be fixed securely and accurately in front of the machine in order to desire task can be accomplished. This fixing duty is the main role of fixtures in the industries.The set includes base plates, supports, locators, clamps and various other accessories.Fixtures are widely used in the industries for production because of their feature and advantages [3].

Welding is a metal joining process by heating of the materials to a suitable temperature with or without the application of pressure, or by the application of pressure alone, with or without the use of filler metal. Welding isone of the most common processes in the manufacturing industries.The purpose of a welding fixture is to hold the parts to be welded in the proper relationship both before and after welding. Welding fixture will maintain the proper part relationship during welding [2]. The process of fixture designing and manufacturing is considered complex process that requires the knowledge of various areas, such as geometry, tolerances, dimensions, procedures and manufacturing processes. Good fixture design will, of itself, largely determine the product reliability.

Welding fixtures are typically the most common devices used to align and retain the various pieces for welding.

Fixture design plays an important role at the setup planning phase. Proper fixture design is crucial for developing product quality in different terms of accuracy, surface finish and precision of the machined parts in existing design the fixture set up is done manually [1].

While designing a fixture it is quite possible, even for an experienced person to overlook some basic aspects of fixture design. It is not necessary that these kinds of situations arise only due to lesser technical knowledge. While designing this work, a good number of literatures and titles written on the subject by renowned authors are referred.

II. WELDING FIXTURE DESIGN OBJECTIVES

The design of fixture for any manufacturing processes has many objectives. The objectives are differs from one another with respect to the type operation to be done [2]. The main design objectives for designing a welding fixture are

- To hold the part in the most convenient position for welding
- To provide proper heat control of the weld zone
- To provide suitable clamping to reduce distortion
- To provide clearance for filler metal
- To provide for ease of operation and maximum accessibility to the point of weld.

III. COMPONENT DETAILS

The component is consists of 2 parts, which are front plate, two bushes. Front plate made up of cold rolled steel, weighing 0.108 Kg. Cold rolled steels has high strength and stiffness. Cold rolled steels are non-shrinking at ambient temperatures [4]. So here for the front plate Cold rolled steels are used. Bushes made up of OHNS (Oil hardened non-shrinking steel) each bush weighing 0.0153

Kg respectively. OHNS steels have good temperature characters and excellent toughness [5]. The finished component is used in footrest stand of the motorbikes. The operation to be performed on component, using designed fixture set up is welding of bushes to the front plate. *Fig.1* shows the component.

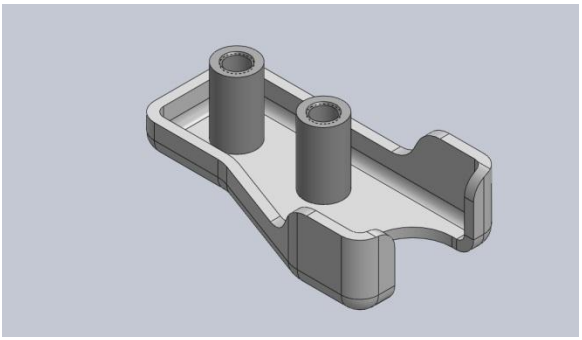

Fig.1: Component

IV. FIXTURE SET UP

Designing a welding fixture for a component is not an easy task. The component has to be located properly. Since this component has flat surface at the bottom it is easy to locate the component on rest pad. The fixture consists of three locating pins and these pins restrict the movement at the either side of the component. A circular locating pad is used to locate the circular shaped region of the component. There are two more locating pads used to locate the component which is also used to align the bushes with the component. The bushes are fixed properly to the plate with help of clamping. The clamping punch applies the load on the bushes so that the bushes cannot be moved. The fixture also consists of one base plate,one rest plate, two supporting plates and C clamps are used for clamping. In the operation the component is placed on the fixture, bushes are placed in the required positions on the component, with help of handling lever the clamping punch descends towards the bushes and restrict the movement of bushes. Once the bushes are fixed to the component then welding operation will start. Once the welding is done the clamping punch move upwards with the help of lever.*Fig.2, Fig.3* shows the different views of the fixture.

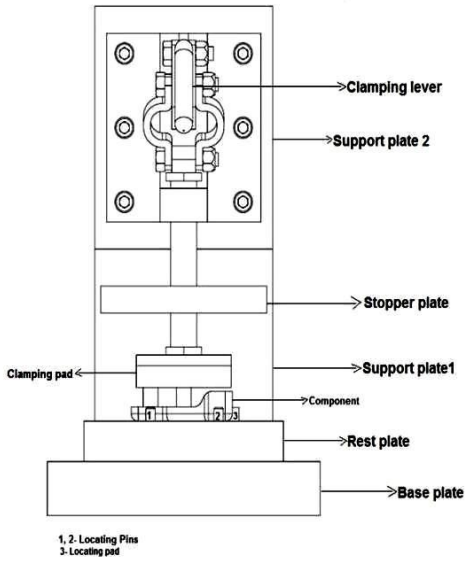

Fig.2:2DFront view

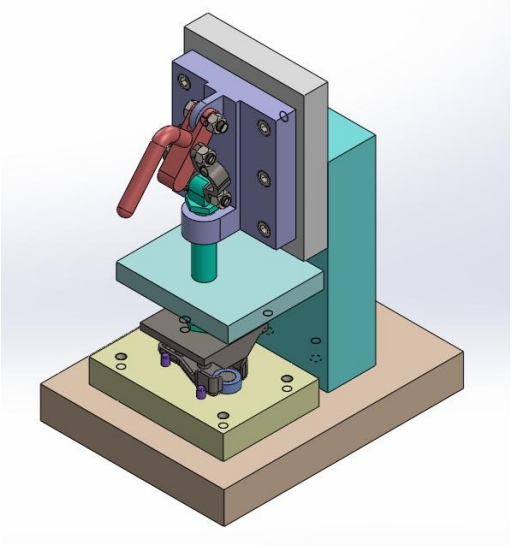

Fig.3: Isometric view

V. Location and clamping considerations

It is very important to understand the meaning of location before understanding about fixtures. The basic principles of locating and holding that apply to the machining fixtures can also be applied to welding fixtures. The locating arrangement should be decided after studying the type of work, type of operation, degree of accuracy required. Before deciding the locating points it is necessary to find out the all possible degrees of freedom of the work piece. Then some of the degrees of freedom or all of them are restrained by making suitable arrangements usually the locaters are used to restrict the degrees of freedom. Usually 3 2 1 locating principle is used for locating a work piece [1].

A clamping device holds the work piece securely in a fixture against the forces applied over it during on operation. Provide clamps that are quick acting, easy to use and economical. Clamps should be integral part of fixture. In case of welding fixtures the Clamps used must hold the parts in the proper position and prevent their movement due to alternate heating and cooling. Clamping pressure should not deform the parts to be joined [6].

Considering the locating and clamping factors, the locating is accomplished by using 5 locating pins and a circular locating pad. Clamping is accomplished by using C clamps.The complete fixture assembly weighs 40 kg excluding component weight.

VI. ANALYSIS

Analysis has been carried out by using finite analysis method with help of ansys software. The analysis has been carried out in two stages. In the first stage the solid model of the component is selected and geometric conditions are selected, direction of the force is selected and clamping load of 1N is given and results are evaluated using the software. In the second stage the boundary conditions are selected, with initial temperature of 30ºC (room temperature) is given. Convection coefficient of 20 W/m² is given. Initial welding temperature of 600ºC is given as input. Then results are evaluated using the software.The analysis results for the componentare shown in *figures 4-9.*

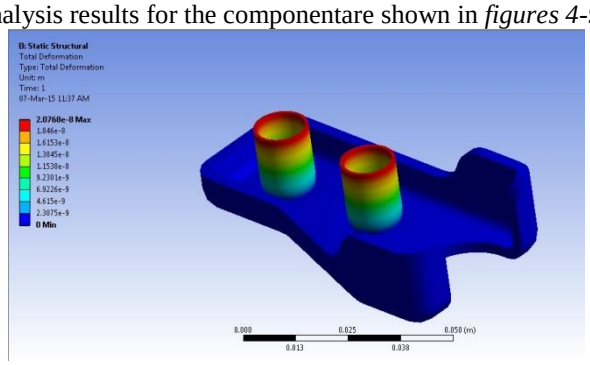

Fig.4:Total deformation on component due to clamping load

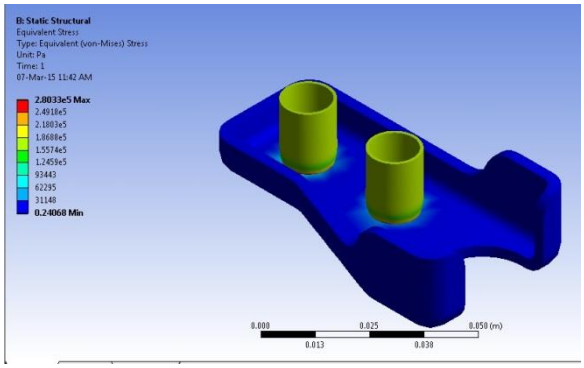

Fig.5: Stress in the component due to clamping load before welding

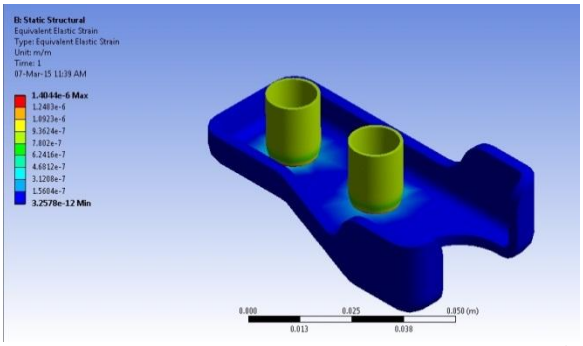

Fig. 6: Strain in the component due to clamping load before welding

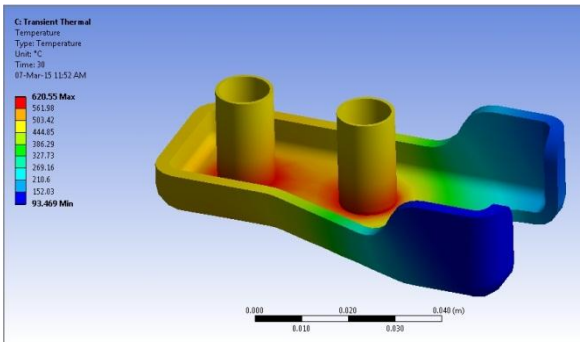

Fig. 7:Temperature distribution in the component during welding

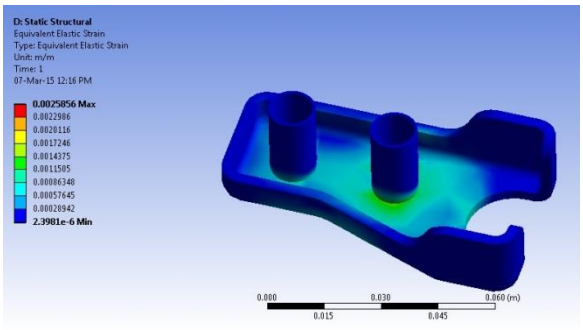

Fig.8: Strain in the component due to clamping load after welding

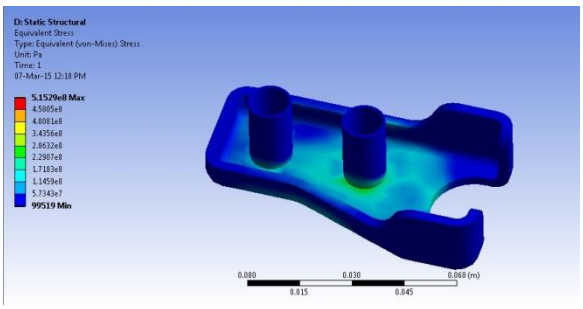

Fig.9: Stress in the component due to clamping load after welding

VII. RESULTS AND DISCUSSION

Fig.4 shows the total deformation in the component due to the clamping load. As anticipated, the maximum deformations are occurs at the top of the bushes. The deformation is minimal for this load. So the clamping load doesn't affect the work piece much.

Fig.5 shows the stress in the component due to clamping load. Stress in the component is in acceptable limit [5].

Fig.6 shows the strain in the component due to the application of clamping load. Since the clamping load is minimum on the component. The strain in the component is low and in the permissible limit.

Fig.7 showsthe temperature distributions in component during the welding process. As anticipated, the peak temperatures are observed at the welding location. The temperature distribution varies as the welding torch moving circularly around the bushes.

*Fig.8*shows the strain in the component after welding, since there is a structural change in the component after welding, the strain in the component is low and in the permissible limit.

*Fig.9*shows the stress in the component after the welding. Stress in the component is in acceptable limit [5]. The stress in the component is because of clamping load used for clamping.

VIII. CONCLUSIONS

This paper addresses the fixture design verification issue. In this paper, the work piece location, clamping stability, deformation, stresses and strains in the component due to clamping load are taken into account. Even the stress and strain in the component due to clamping load is also considered.

Concluding contributions of this paper in the area fixture design are

- Fixture design for welding process, and its manufacturing considerations
- Locating, clamping and work piece mounting with respect to welding process
- Analysis of the component

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