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Reduction in Cycle Time of Lift Arm of a Wheel Loader by Developing Fixture

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Abstract—*For the growing heavy industrial sectors the demand for Wheel loader of various capacities is increasing day by day. Therefore, the company must meet the demand through the available facilities so that the company has to sophisticate the manufacturing processes in the existing plant. Despite existing models in other company's being manufactured in the plant, there is a need and demand for different higher capacity models. In this paper, an attempt has been made to Develop, Modify and Generate concepts to mount the sub-assemblies from the Wheel loader lift arm component onto a Fixture to perform Welding on the sub-assemblies. Techniques suggested in this paper help in saving Cycle time per Job and also help in reducing the Man hours, which might otherwise have been spent on manual Welding of all the Sub-Assemblies by making the process Automatic. So it is necessary to develop a fixture to reduce the cycle time of a lift arm by considering Critical to Quality in the assembly. After designing this fixture we can save 1 hour per Lift arm assembly*

Keywords*: Wheel loader, Lift arm, sub-assemblies, Fixture, CTQ.*

1. INTRODUCTION

A fixture is a device for locating, holding and supporting a work piece during a manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for the particular processing operation. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually. [1].

Generally, all fixtures consist of the following elements [2]:

- Locators: A locator is usually a fixed component of a fixture. It is used to establishand maintain the position of a part in the fixture by constraining the movement ofthe part.
- Clamps: A clamp is a force actuating mechanism of a fixture. The forces exerted by the clamps hold a part securely in the fixture against all other external forces.
- Fixture Body: Fixture body, or tool body, is the major structural element of a Fixture. It maintains the relationship between the fixturing elements namely, Locator, clamps, supports, and the machine tool on which the part is to be processed.
- Supports: A support is a fixed or adjustable element of a fixture. When severe part displacement is expected under the action of imposed clamping and processing

2. PROBLEM DEFINITION

Presently there are no fixtures for lift arm of a Wheel loader this is otherwise being welded by using hoist hook carriers and rotated to desired positions every time by cranes also measuring dimensions every time so which leads to high 3m's (money, men, machine) and increases manufacturing lead time and extremely unsafe. So it is necessary to develop a fixture to reduce the cycle time of a wheel loader.

Fig. 2.1: Lift arm assembly

2.1 Lift arm Function

Arm connects the bucket and is controlled by a hydraulic system. The lift arm can be raised up to the Pre-set level by

adjusting the proximity switch for the lift arm, mounted the front frame. This is function is convenient when loading on to a dump truck, hoppers

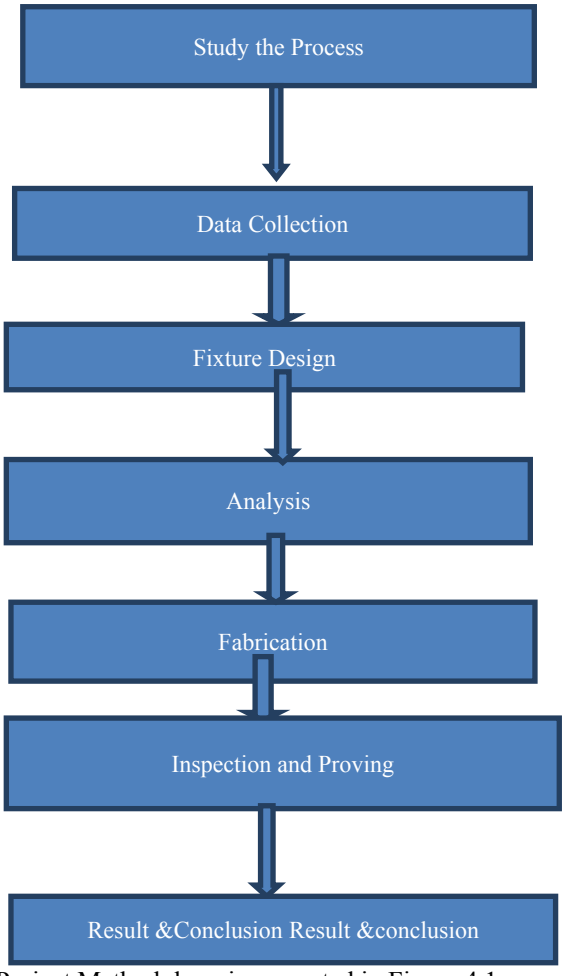
3. OBJECTIVES

The main objective of the work is to design a Tack welding fixture to reduce the Manufacturing lead time of Lift arm of a wheel loader the design and development of the selected concept of the tack welding fixtures was carried out using Auto CAD and Catia tools.

- ReduceScrap And Reworks Of Lift Arm Assembly.
- Increase Productivity
- Reduce Operator Fatigue

4. METHODOLOGY

The development of tack welding fixture started with the study of the existing process used for tack welding of lift arm and bucket in Wheel loader tack welding stage where in it required to be reduce cycle time and improve productivity. Considering the most efficient design 3D modeling of the fixture is generated in CatiaV20.



The Project Methodology is presented in Figure 4.1

5. FIXTURE DESIGN

Fixture planning is to conceptualize a basic fixture configuration through analyzing all the available information regarding the material and geometry of the work piece, operations required, processing equipment for the operations and the operator. Fixture element design is either to detail the design drawings committed on paper or to create the solid models in a CAD system of the practical embodiment of the conceptual locators, clamps and supports

5.1 PRINCIPLE OF LOCATION

The 3-2-1 principle is also known as six point principle which is used to constrain or prevent the body from moving in any direction along x-x, y-y and z-z axes.

In lift arm assembly following are the Critical to Quality (CTQ) Issues

- Orientation of the Tube
- Gap between the two arm
- Clamping
- Gap between the plates in cross bar assembly

5.2 FIXTURE DESIGN CRITERIAThe following design criteria must be observed during the procedure of fixture design:

- Design specifications.
- Factory standards.
- Ease of use and safety.
- Minimum changeover / set up
- Economy.

5.3 Tool specification

Tool	: Fixture.
Type of fixture	: Tack weldingfixture.
Operating mode	: Manual tack welding.
Type of clamping	: Manual screw clamping.
Loading and Unloading	: Manual.
Loading of Component	: One at time.

5.4 Raw material selection

Material selection is a matter of quality and cost. The properties of the material must be adequate to meet design requirements and service conditions. While manufacturing any machinery parts, moulds, press tools, equipment, gauges, jigs and fixtures etc., raw material selection plays vital role. Selection of raw material depends upon the function of manufacturing parts.

Materials used in this fixture are Mild steel &Carbon steel

- Mild steel is a low carbon steel with no precise control over the composition or mechanical properties. The cost is low in comparison with other steels and this is used for covers, sheet metal work, tanks, fabricated items, etc.

- Carbon steels are medium carbon steels with a carbon percentage varying between 0.35% and 0.6%. Carbon steel is the preferred steel of this category and is suitable for applications such as shafts, gears, keys footed clutch, threaded fasteners requiring high strength, pins, etc. Carbon steel can be induction hardened for wear resistance**.**
- Lift arm assembly mainly divided in to two sub-assembly cross bar assembly& arm assembly, so first develop a fixture for cross bar assembly as shown below.
- It mainly consist of tube, plates ribs, and gusset

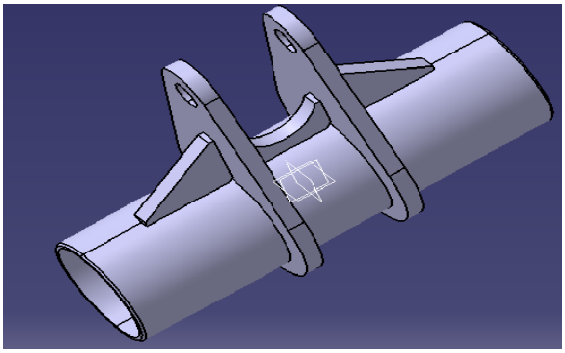


Fig. 5: 1cross bar assembly

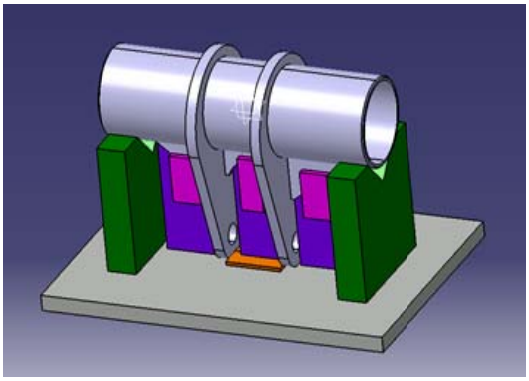


Fig. 5.2: Cross bar assembly with fixture

After completion of crossbar assembly, place arm (LH) to another fixture with the help of crane then clamp the component as shown below

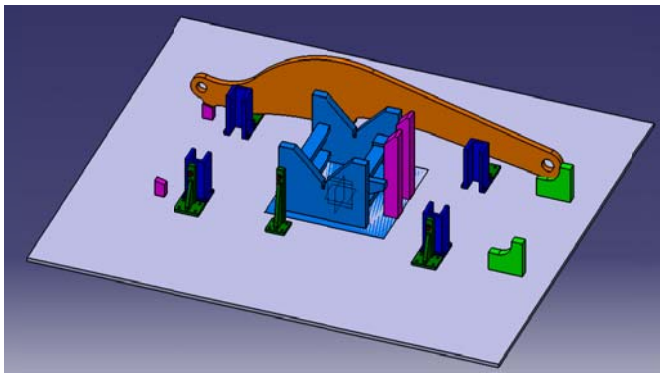


Fig. 5.3: Placing of LH arm plate

Below fig shows that both LH&RH arm plates are placed with the help of cranes and also clamping is done

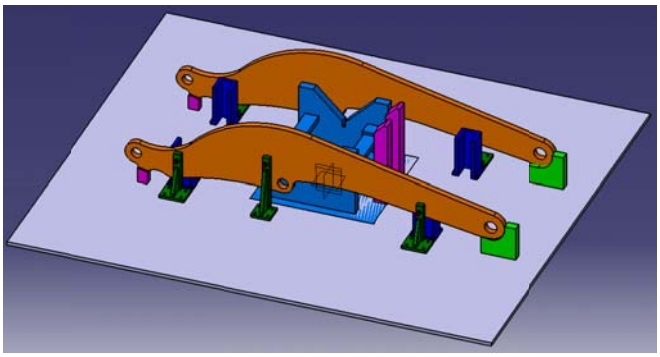


Fig. 5.4: Placing of both LH& RH arm plate

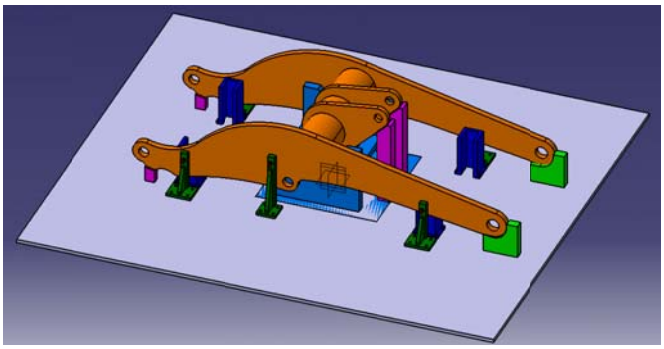


Fig. 5.5: Lift arm assembly with fixture

After placing the arm then place the cross bar assembly to the fixture here with the help of MIG welding the tack welding operation is donethen the assembly send to the vendors for continuous welding

6. CALCULATION

Calculations for screw clamping

T=KDF

Terms used in the formulae below

T =Tightening torque to be applied to the fastener.

F =The Preload (or clamp force) in the fastener.

K = Torque co-efficient= 0.2 (for dry condition)

D= Diameter of Screw; 24mm (M24 screw)

F= T/KD

Maximum torque applied= 700 N-m

(Maximum Torque is determined from practical condition by using Torque rinch)

F= 700/0.2×0.24

F= 14580N

Stress Induced in the bolt $\sigma = F/As$ where As= Pitch of cross section of bolt

$As= \pi (d1+d2)^2$

4 2

As = 389.9mm2

= 14580/389.9

$\sigma = 37.39$ n/mm^2

7. CONCLUSION

The Concept Generation of both cross bar sub assembly and arm assembly have successfully been carried out. Due to this fixture the setup time reduces from 80min to 40min so we can save 40min per lift arm assembly and also increases productivity of wheel loader. And I wish to thank and express their sincere gratitude to L&T Construction Equipment Limited, Byatarayanapura, and Bangalore for giving this wonderful opportunity.

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