Design and Development of Multi-Fixture for Tractor Attachment

G. Vishvanathan[1], P. Sandeep[1], K.S.M. Thennavan[1], S. Abisekar[1], Dr. S.V. Suresh Babu[2]

[1]*Department of Mechanical Engineering, Adhiyamaan College of Engineering, Anna University, Hosur, India*
[2]*Professor, Adhiyamaan College of Engineering, Anna University, Hosur, India*

Abstract **–The theme of this work is to design and develop a multi-fixture for a tractor as an attachment. Influence of multi-fixture instead of using a single fixture, the benefit of this fixture is to increase the production rate with accurate clamping design, through which the space requirement of fixtures are highly reduced by designing this fixture performance of the labors are improved, where mounting and unmounting the work pieces are easier. Mismatching and misalignment of the work piece are rectified by proper space allocation for each component to be attached.**

Keywords: **Multi-fixture, Single- fixture, clamping type, production rate, work performance, 3-2-1 Locating principle**.

I. INTRODUCTION

The fixture is a tool for holding a work piece during manufacturing operation. For supporting and clamping the work piece, separate device is provided. Where frequent checking, individual marking, position and non-uniform quality in manufacturing process is eliminated by fixture. This increase productivity and reduce operation time. It is widely used in manufacturing fixtures, it has a direct impact upon product quality, productivity and cost. In General, the cost associated with fixtures design and manufacturing are about to 10%-20% of the total cost of a manufacturing system. On the increasing intense, global competition which forces every manufacturer to make the best effort to sharpen its competitiveness by enhancing products, quality, minimizing the production cost and reducing their lead time to bring products to the market. By introducing multi-fixtures it is possible to reduce the lead time and cost for fixture manufacturing.

II. LITERATURE REVIEW

Abhishek Das, et.al. (2015) has studied on the fixture design optimization considering production batch of compliant non-ideal sheet metals parts these approaches aim at fixture layout optimization of single ideal parts and to improve the probability of joining feasibility index by determining an N-2-1 fixture layout.

C.A. Kubade, et.al. (2016) has studied on the design and analysis of welding fixture for Automotive Component using FEA in this approach design of fixture with the use of analytical method and FE analysis to pneumatic cylinder selection, positioning of unit, power clamps and strength criteria of the material.

Prof. Nilesh Chanewar, et.al. (2017) has studied on the A Review Design and Development of jig and fixture for circular welding these study gives detailed information about jigs& fixture and their function.

K. Sakthisivam, et.al. (2017) has studied on the design and fabrication of rotary milling fixture these study gives more information about the factors to be considered while designing jigs and fixture.

Ravikumar Rampur, et.al. (2015) has studied on the Fixture design for self-loading concrete mixer's chassis full weld these study gives information about the degree of freedom, links and joints.

III. PROBLEM IDENTIFICATION

In the production sector manufacturing a structure on a single-fixture takes 6 to 7 hours, highly skilled labors are required for the proper assembling of parts under specified area on required dimension. Mounting and Unmounting of the work piece require more time. Storage of fixtures takes large space on the production area. Separate measuring methods are needed to avoid mismatching on the structure.

IV. FIXTURE SPECIFICATIONS

Fixtures are mainly a work holding device which must be stable in condition while working, due to this selection of the material should with stand high vibrational force and compressive force. Where the clamping material poses high clamping force. Based on this criteria following specification are taken and shown in the table1.

Table -1 Specification of fixture

Width of the fixture	1200 mm
Length of the fixture	2400 mm
Height of the fixture	250 mm
Plate thickness(MS)	8mm
No of support	6
Allen bolt A2 (SST)	8x25 (20 pieces)

Nyloc nut A2 (SST)	M8 (20 pieces)
C-clamp	250mm to 12mm
Toggle clamp	120mm to 8mm

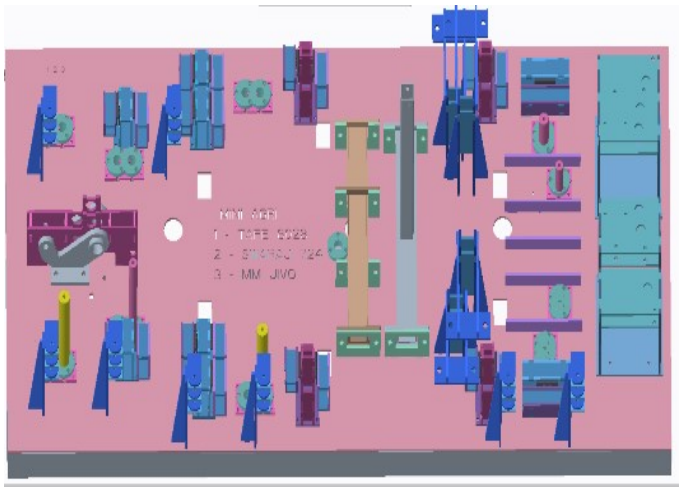

Fig-1 Multi-fixture

V. FIXTURE DESIGN

In a mass production unit to increase the production rate and reduce the production cost by minimizing the assemblage and inspection time, where this necessity is achieved by proper designing of the fixture. The fixture should be easily interchangeable to improve the assemblage time between the works.

In general design of fixtures consists of following elements:

- Locating elements –These elements are position the workpiece accurately with the tool guiding or setting elements in the fixture.
- Tool guiding elements –These element guide the tool in correct position with respect to the workpiece. In the welding process these element shows the area to be welded.
- Clamping elements –In these element the workpiece is securely hold by a high clamping force during the operation.
  Generally, every part has 6 degree of freedom, where 3 rotary and 3 linear. While processing the parts all the degree of freedom should be arrested to ensure the proper location of the parts in area.
- 3-2-1 locating principle are used to locate the support as shown in fig-2
  Where:
  a) 3 stands for –where minimum 3 rests with clamps to restrict the 2 rotary motion and 1up & down motion.
  b) 2 stands for – It restrict 2 direction in an established plane by locating a round pin in a round hole on it.
  c) 1 stands for –It restrict the rotary motion of the plane by locating a round pin in a slot on it.

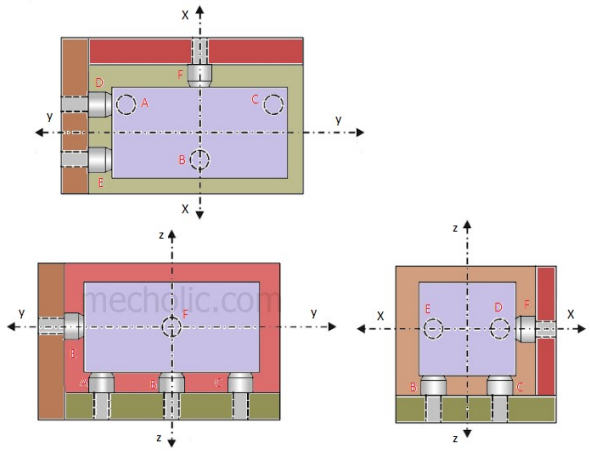

Fig -2 3-2-1Locating principle

5.1 TIME STUDY FOR STRUCTURE ASSEMBLY USING SINGLE-FIXTURE

5.1.1 SWARAJ-724

Channel Assembly	-10mins
Assembly part and Full weld	-45mins
Center Support Setting and Joint Support	-10mins
Front Plate Mounting and Setting	-50mins
Channel and Structure Plate, Base Plate Mounting	- 82mins
Back Support and Center Beam Mounting and Setting	-47mins
L-Bracket, Gadget and Plate Hole	-26mins
Outer Supporting Stand	-31mins

Numbering, Dismounting and Removing	-21mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-7hrs 30mins

5.1.2 TAFE-6028

Channel Assembly	-14mins
Assembly part and Full weld	-54mins
Center Support Setting and Joint Support	-8mins
Front Plate Mounting and Setting	-57mins
Channel and Structure Plate, Base Plate Mounting	-93mins
Back Support and Center Beam Mounting and Setting	-44mins
L-Bracket, Gadget and Plate Hole	-20mins
Outer Supporting Stand	-22mins
Numbering, Dismounting and Removing	-27mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-7hrs 15mins

5.1.3 MAHINDRA JIVO

Channel Assembly	-22mins
Assembly part and Full weld	-46mins
Center Support Setting and Joint Support	-10mins
Front Plate Mounting and Setting	-31mins
Channel and Structure Plate, Base Plate Mounting	-77mins
Back Support and Center Beam Mounting and Setting	-32mins
L-Bracket, Gadget and Plate Hole	-23mins
Outer Supporting Stand	-37mins
Numbering, Dismounting and Removing	-44mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-6hrs 40mins

5.2 Calculations:

Production rate:

t -Total Time required for Production a part

Q -Production rate

$Q = \frac{1}{t}$

t_m= actual machining time

t_h = setting up time

$Q = \frac{1}{t_m + t_h}$

Production efficiency:

Λ -production efficiency

$\Lambda = \frac{1}{1+\frac{t_h}{t_m}}$

5.2.1 *SWARAJ 724 –structure assembly*

Production rate:

$Q = \frac{1}{t_m + t_h}$

$Q = 2.2 \times 10^{-3}\ piece/min$

Production efficiency:

$\Lambda = \frac{1}{1+\frac{t_h}{t_m}}$

Λ = 33 %

5.2.2 TAFE 6028–structure assembly

Production rate:

$Q = \frac{1}{t_m + t_h}$

$Q = 2.29 \times 10^{-3}\ {}^{piece}/_{min}$

Production efficiency:

$\Lambda = \frac{1}{1+\frac{t_h}{t_m}}$

$\Lambda = 32\ \%$

5.2.3 *MAHINDRA JIVO–structure assembly*

Production rate:

$Q = \frac{1}{t_m + t_h}$

$Q = 2.5 \times 10^{-3}\ {}^{piece}/_{min}$

Production efficiency:

$\Lambda = \frac{1}{1+\frac{t_h}{t_m}}$

$\Lambda = 36\%$

5.3 *TIME STUDY FOR STRUCTURE ASSEMBLY USING MULTI- FIXTURE*

5.3.1 SWARAJ-724

Channel Assembly	-8mins
Assembly part and Full weld	-32mins
Center Support Setting and Joint Support	-10mins
Front Plate Mounting and Setting	-36mins
Channel and Structure Plate, Base Plate Mounting	-58mins
Back Support and Center Beam Mounting and Setting	-32mins
L-Bracket, Gadget and Plate Hole	-20mins
Outer Supporting Stand	-26mins
Numbering, Dismounting and Removing	-17mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-5hrs 29mins

5.3.2 *TAFE-6028*

Channel Assembly	-11mins
Assembly part and Full weld	-39mins
Center Support Setting and Joint Support	-6mins
Front Plate Mounting and Setting	-33mins
Channel and Structure Plate, Base Plate Mounting	-54mins
Back Support and Center Beam Mounting and Setting	-32mins
L-Bracket, Gadget and Plate Hole	-16mins
Outer Supporting Stand	-12mins
Numbering, Dismounting and Removing	-21mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-5hrs 14mins

5.3.3 MAHINDRA JIVO

Channel Assembly	-13mins
Assembly part and Full weld	-36mins

Center Support Setting and Joint Support	-10mins
Front Plate Mounting and Setting	-22mins
Channel and Structure Plate, Base Plate Mounting	-58mins
Back Support and Center Beam Mounting and Setting	-26mins
L-Bracket, Gadget And Plate Hole	-18mins
Outer Supporting Stand	-22mins
Numbering, Dismounting and Removing	-32mins
Stoppage time	-90mins
Total time taken for Structure Assembly	-5hrs 25mins

5.4 CALCULATIONS:

5.4.1 SWARAJ 724 –structure assembly

Production rate:

Q =3.03x10^{-3} $piece/_{min}$

Production efficiency:

ʎ = 42%

5.4.2 TAFE 6028–structure assembly

Production rate:

Q =3.184x10^{-3} $piece/_{min}$

Production efficiency:

ʎ = 41%

5.4.3 MAHINDRA JIVO–structure assembly

Production rate:

Q =3.07x10^{-3} $piece/_{min}$

Production efficiency:

ʎ = 40 %

VI. RESULT AND DISCUSSION

Analysis of collected experimental data is performed for investigating the effect of process parameter by comparing the Single-fixture and Multi Fixture. Experimental setup is made and carried over structure and arm. The purpose of this setup to increase the production rate and reduction in handling time.

6.1 Effect of Process in Production Time

The effect of Production time compare to Single Fixture, Multi-Fixture take less time to complete setting process and welding process. Series of analysis is made in welding time of a piston rod is shown in chart-1

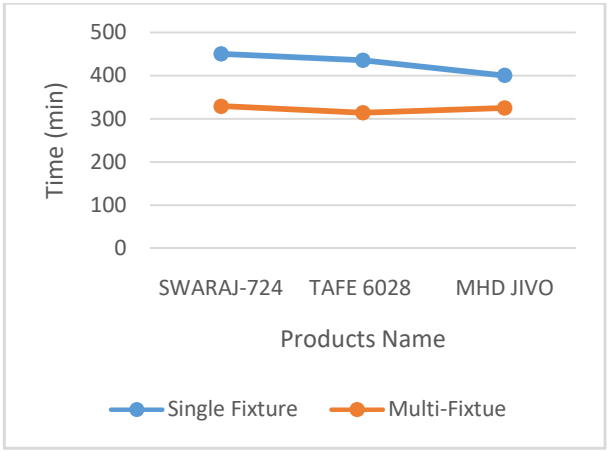

Chart-1: Graph between Production Time on Different product

6.2 Effect of Process in Production efficiency

The effect of production efficiency compare to single fixtures, multi-fixtures takes less handling time to complete a single structure. Series of analysis is made in setting and welding of a structure & arm is shown in chart-2

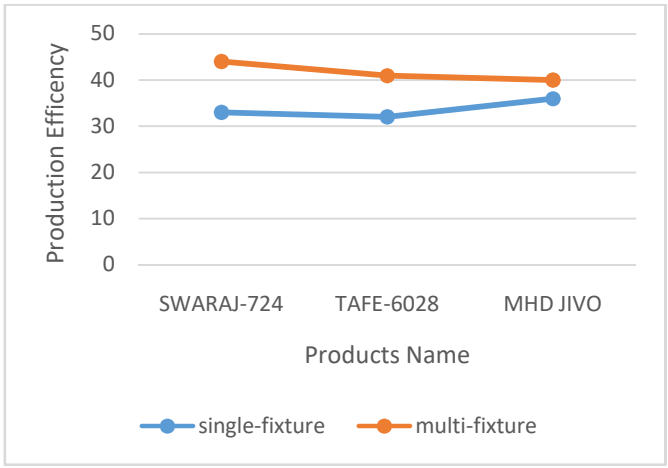

Chart-2: Graph between Production efficiency on Different product

VII. CONCLUSION

An experimental study has been done to determine the profit by implementing the multi-fixture for the setting and welding process. The conclusion may be drawn from the above chart 1&2 compare to single-fixtures, multi-fixtures gives better results. Hence it can be concluded that the process leads to increases the production rate, production efficiency and better quality.

REFERENCES

[1]. C.A.Kubade Welding Fixture for Automotive Component using FEA in Vol-2 Issue-4 (2016), IJARIIE-ISSN (O)-2395-4396

[2]. Djordje, Vukelic, UrosZuperl & Janko Hodolic "Complex system for fixtures selection, modification, and design'' Int J Advance Manufacturing Technology 45:731-748 DOI 10.1007/s00170-009-2014-y, 2009

[3]. Guohua Qin, Weihong, Zhang Min Wan "Analysis and Optimal Design of fixture clamping sequence ASME for publication in the journal of manufacturing science and engineering, 2006.

[4]. R.Forstmann, j.Wagner on "The Rapid Fixture Approach "Procedia Manufacturing 11 (2017) 633 – 640.

[5]. Abhishek Das on the fixture design optimization considering production batch of compliant non-ideal sheet metals parts in vol-1 (2015) pg.no 157-168 procedia manufacturing.

[6]. Prof. Nilesh Chanewar on A Review on Design and Development of jig and fixture for circular welding in IJSER vol-8 Issues -3 March-2017