Design and Analysis of Fixture for Milling Quadrant Face of Hydraulic Lift Top

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Abstract - *As per the company's customers requirement the fixtures are designed and produced. The operations should be such that there should be less wastage, less cost in production, improved quality, increase in the overall production, reduction in cycle time. To design any fixture for a component for any operation, a detailed study has to be made. In this case a Hydraulic lift top's drawings are studied. The basic design starts with the face on which the milling operation has to be carried out. A quadrant face of this hydraulic lift top has to be milled. A thickness of 4mm has to be milled from this surface. The best way to mill this surface is by designing a new fixture instead of conventional method designs. This will make easier to machine the work piece and reduction in cost per work piece.*

Key Words: Hydraulic Fixture, Hydraulic Lift top, ANSYS, Analysis, production, etc

1. INTRODUCTION

A fixture is a device which is used for holding a work piece while machining. The Fixture name is given because of the fact that in a fixed position, the fixture is always fastened either to a machine or table. In case of drill jig, there are special arrangements for guiding the tool. But in case of Fixtures, there are no such arrangements for tool guiding.

The feasible design and good performance of a fixture will directly affects the accuracy of the machining process. In positioning parts for fabricating purposes, different types of tooling are used and in common these are also called as fixtures.

1.1 Problem statement:

To design any fixture for a component for any operation, a detailed study has to be made. In this case a Hydraulic lift top's drawings are studied. The basic design starts with the face on which the milling operation has to be carried out. A quadrant face of this hydraulic lift top has to be milled.

A thickness of 4mm has to be milled from this surface. The best way to mill this surface is by designing a new fixture instead of conventional method designs. This will make easier to machine the work piece and reduction in cost per work piece.

1.2 Objectives:

1. To design and develop a fixture for rough milling of quadrant face of a hydraulic lift top up to a depth of 4mm.
2. To carry out finite element analysis using software package ANSYS.
3. To study the production time.

2. PART MODELING:

The parts modeling have been done using the Solid Edge software.

2.1 Clamp:

The clamp is manufactured using the mild steel. The clamp is of dimension 200*47*40mm. The clamp lands on the circular or elliptical type shape of the work piece. This will hold the hydraulic lift not to move during the machining process. Fig 2.1 shows the isometric-view of clamp.

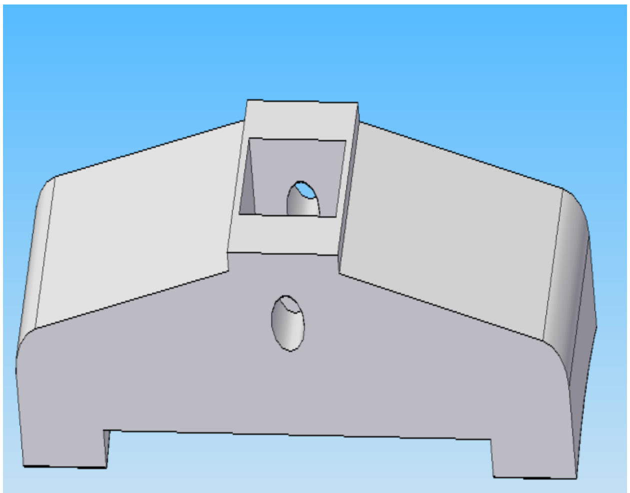

Fig-2.1: Clamp

2.2 Clamping plate:

The clamping plate is made to give support to the clamp. The clamping plate is made with the mild steel. The plate is made with the dimensions as 530*70*30 mm, then the upper part of the clamping plate is created to hold the clamping cylinder. The fig 2.2 shows the image for clamping plate.

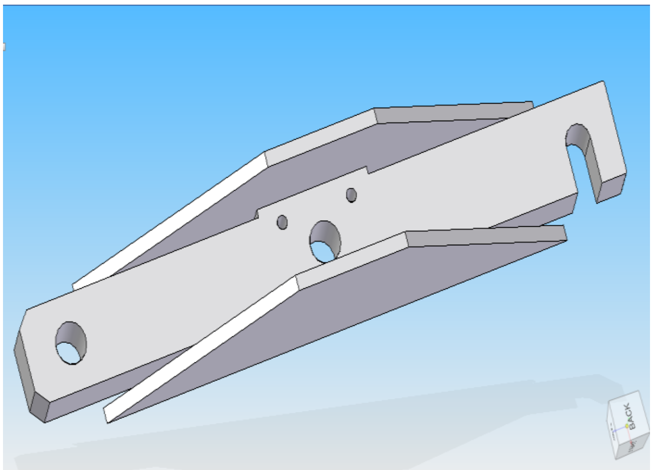

Fig -2.2: Clamping plate

2.3 Assembled Fixture:

All these parts and smaller parts like standard nuts and screws are used as per the standards. The assembly is the last step in this process. Assembled view of the fixture is shown in fig 2.3.

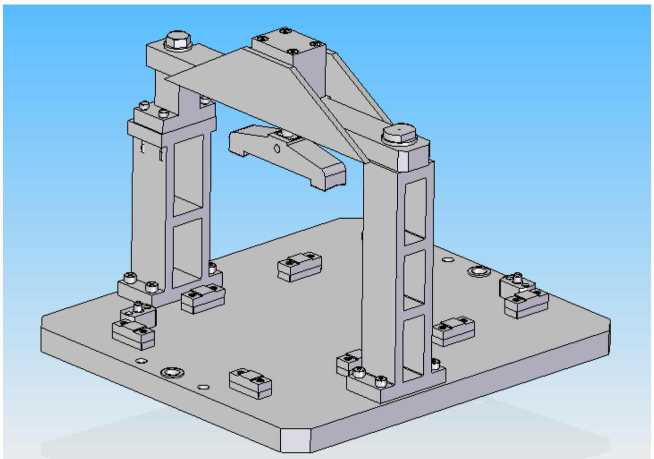

Fig -2.3: Assembled Fixture

3. FEM RESULTS AND DISCUSSIONS:

To check the feasibility of the design, the fixture has to be analyzed analytically. Since the design is complex, the meshing of the component is impossible to measure. Therefore the major parts of the fixture have been analyzed here. The analysis has been done using ANSYS software package.

3.1 Clamp:

The FEM results are shown in figure 3.1 and 3.2. Clamping bolt is having yield stress 250 MPa. The Maximum stress obtained is 18.298 MPa and the Von mises is 41.578 MPa. The total number of nodes is 33302 and the elements are 21521.The Fig 3.1 shows the Maximum stress acting on the clamp and

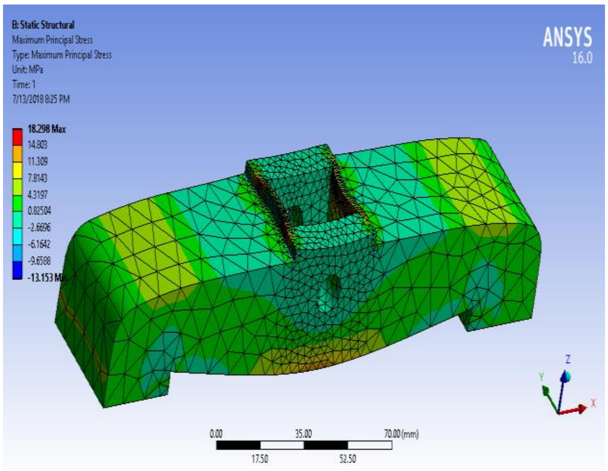

Fig -3.1: Maximum stress acting on Clamp

The total deformation is 0.0092 mm. Here the type of element used is triangular element. The Fig 3.2 shows the Total deformation in clamp.

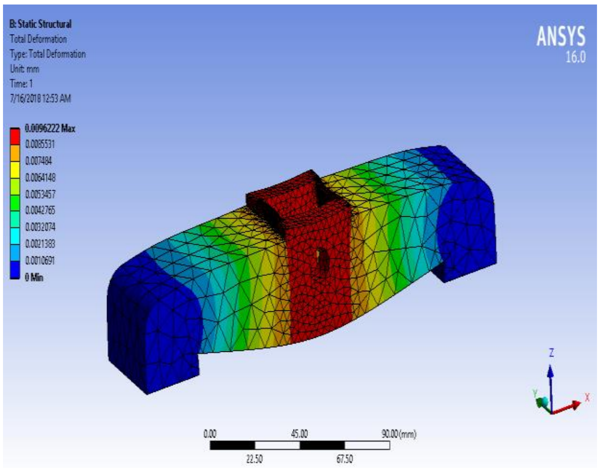

Fig -3.2: Total deformation in clamp

4. VALIDATION OF THE RESULTS:

Theoretical calculations have been done for the validation of finite element model results. Stresses acting on the critical parts, the validation has been done.

4.1 Design calculations:

Following are the parameters for the calculation. And the calculations have been done as follows:

Power of Motor = 10 hp = 7.5 KW

Speed of milling cutter = 319 rpm

Dia. of cutter D_c = 100 mm

Depth of cut a_p = 1 mm

Table Feed V_f = $100*10^3$ mm/min

Number of teeth= 7

4.1.1 Cutting speed:

$$V_c = \frac{\pi * Dc * n}{1000} = \frac{\pi * 100 * 319}{1000}$$

Cutting speed Vc = 100.216 m/min

4.1.2 To calculate feed rate per tooth:

$$f_z = \frac{Vf}{n * c} = \frac{100 * 1000}{145 * 24}$$

f_z = 28.73 mm

4.1.3 To calculate Force:

T = F * r
Where, r = radius of cutter
493.929 = F*157.5*10^{-3}
F = 3136.06 N

Therefore, the force exerted by cutter upon the fixture is **F = 3136.06 N**

4.1.4 Stresses on Clamp:

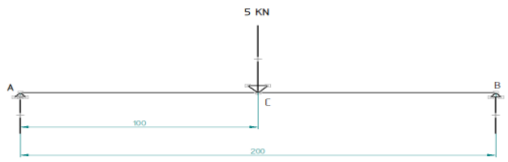

Fig-4.1 Free Body Diagram

Since the clamp experiences the major force that needed for the clamping of the work piece. The clamp here considered as rectangular plate since there is not much of difference between the structures. To calculate the forces the free body diagram has been drawn as shown in the fig 4.1. Material of the clamp used in clamp is Mild Steel. The young's modulus of the same is 207 GPa.

As the force acts exactly at the center, the force is equally distributed at both the ends of the clamp.

The clamp has height of 47 mm and breadth of 40 mm. To find out the stress we need moment of inertia. Therefore,

$$I = \frac{bh^3}{12} = \frac{40 * 47^3}{12} = 346076.66 \text{ mm}^3$$

Moment equation is given by,

$$M = \frac{WL}{4} = \frac{5000 * 200}{4} = 250000 \text{ N-mm}$$

Considering the general formula,

$$\frac{M}{I} = \frac{\sigma}{y} \Rightarrow \frac{250000}{346076.66} = \frac{\sigma}{h/2}$$

$$\frac{250000}{346076.66} = \frac{\sigma}{47/2} \Rightarrow \sigma = 16.759 \text{ MPa}$$

Hence we can correlate the results obtained from FE results with the theoretically calculated results. The Maximum stress obtained is 18.298 MPa by FE results and theoretically we get 16.759 MPa which is almost equal.

5. CONCLUSION:

- The fixture has been designed effectively well within the safe standards. The critical components have been studies analytically in static mode. Results indicated no critical component crosses the yield stress for the same.
- Dowel pins, rest pads, round head pins, Diamond Head pins are made of case hardened steels. This provides an extra robustness for the production.
- The rest pads are attached with the pneumatic sensors. The pneumatic sensors help the operator during loading of the work piece. If the work piece is not properly placed, these sensors will indicate an error. This action makes the work error proof.
- The machining time of hydraulic top with the fixture is of 2.12 min. This hydraulic top is machined around 200 per day.

REFERENCES

[1] Shailesh S Pachbai and Laukik P Raut, Design and development of hydraulic fixture for machining hydraulic lift housing, ISSN-2778-0149 (2014), International Journal of Mechanical Engineering and Robotics Research.M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Ingrid Delyova, Numerical solution of suggested fast fixture hanger, MMaMS 2012, Procedia Engineering 48 (2012) 73-76, Science Direct.

[3] Wu Jingze, Zheng Wenyuan and Zhao Pentago, Design and mode analysis of random vibration test fixture of some airborne heat exchanger, International Conference on Aircraft Utility Systems (AUS) (2016).

[4] Liqing Fan, B.N. Jagadish, A. Senthil Kumar, S. Anbu selvan, Shung-Hwee Bok, Collaborative fixture design and analysis using service oriented architecture, IEEE Transactions on Automation Science and Engineering Vol. 7, No 3 July 2010.

[5] Jigar D Suthar, K.M. Patel, Sanjay G Luhana, Design and analysis of Fixture for welding and exhaust impeller, Chemical, Civil and Mechanical Engineering tracks

International conference, Procedia Engineering 51 (2013) 514-519.

[6] Ilker Erdem, Christoffer Levandowski, Cecilia Berlin, Henrik Kihlman, Johan Stahre, A novel comparative design procedure for reconfigurable assembly fixtures, CIRP Journal of Manufacturing Science and Technology 19 (2017) 93-105.

[7] J. Cecil, A Clamping design approach for automated fixture design, The International Journal of Advanced manufacturing Technology (2001) 18:784-789.

[8] Central Machine tools Institute, "Machine Tool Design Data Handbook", Tata Mcgraw Hill Education private Limited 2014.

[9] Standard Handbook of Machine Design 3ed-Shigley, Mischke.

[10] Joshi P. H, Jigs and Fixture, Tata Mcgraw Hill publishing company, New Delhi.