

Research Article

Design and FEA Analysis of Fixture for Multitasking operations

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Accepted 04 Aug 2016, Available online 05 Aug 2016, Vol.6, No.4 (Aug 2016)

Abstract

The main aim of this paper is to minimize the setup time and increasing the productivity by continuous product manufacturing operations on single machine. The design and FEA analysis has done on modular fixture which is used in manufacturing suction and discharge casing of pumps. Jigs and Fixtures are special purpose tools which are used to facilitate production (machining, assembling and inspection operations) when the work piece are to be produced on a mass scale. The purpose of the fixture is to holds, locates and supports the work piece securely. Modular fixture is nothing but fixture to hold work piece for multiple operations on a single clamping and a same machine. A fixture is bolted or clamped to the machine table. Our research aim is to minimize the setup time and increasing the productivity by continuous product manufacturing operations on single machine.

Keywords: FEA, Fixture, Analysis.

1. Introduction

A fixture is a production tool that locates, holds and supports the work securely so the required machining operations can be performed. A fixture holds the successive work piece in identical positions. Also its massive and heavier construction than a jig, and it's fixed or bolted to table of machine to ensure proper rigidity. Fixtures vary in design from relatively simple tools to expensive, complicated devices. It designed to hold work piece for various operations on most of the standard machine tools.

From a layout point of view, fixtures have six basic functional requirements:

- (1) Stable resting,
- (2) accurate localization,
- (3) support reinforcement,
- (4) stable clamping,
- (5) foreclosure
- (6) Quality performance.

The functions have strong precedence conditions. The first five functions are required at the fixturing stage, and sequentially. When a work piece is placed into a fixture, it must first assume a stable resting against the gravity. Then, the locators should provide accurate localization.

Supports are moved in place, and finally clamps are activated for the part immobilization (force-closure). The part location must be maintained in the

process of instantiating clamps without work piece lift-off. The performance of the fixture is ultimately defined as work piece geometric error during the manufacturing stage. The geometric error is mainly determined by the fixture localization accuracy and the work piece static and elastic deformation during manufacturing. There are additional constraints to be satisfied such as interference-free and easy loading and unloading. Modular fixture is nothing but fixture to hold work piece for multiple operations on a single clamping and a same machine. The various types of fixtures are Plate fixture, angle-plate fixtures, Vise-jaw fixtures, Indexing fixtures, multistation fixtures, profiling fixtures. The different operations that use fixtures are boring, drilling, milling, turning, facing, etc. According to KSB standard, the product namely HG3 and HG4 i.e., suction and discharge casing manufacturing required fixture which is use for all operations on product like turning, facing, boring, drilling, milling, etc. on DMU mill-turn center. The machine is 5-axis machine

2. Objectives

Fixture are used to locates and constrain work piece during a machining operations, minimizing work piece and fixture tooling deflections due to clamping and cutting forces are critical to ensuring accuracy of the operations. Machining fixtures are mostly designed and manufactured through trial and error method which proves to be expensive and time consuming to the manufacturing process. For proper manufacturing of work piece, it must be appropriate located and

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clamped, making it imperative to develop that eliminates time-consuming locating and clamping. These are crucial for accuracy, finishing of machined work piece.

A modular fixture is used to machining different operations on single alignment. It is used to establish and maintain the required position and orientation of a work piece in a machine tool and in process planning as it directly affects machining safety and machining accuracy. The main requirement of fixture designing is that work piece must be stable for whole machining operation in setup. The fixture stable the work piece that means it is fully restrained the work piece from static clamping forces and machining forces. The parameter need be chosen properly since the insufficient clamping forces cannot provide fixturing stability while unnecessarily high clamping forces will cause excessive work piece deformation.

3. Design

To analyze the maximum and minimum dimensions of the work piece and understand the concept we design two dimensional design of require specifications in CAD software. Because we design for maximum as well as for minimum, so we overlap HG3 and HG4 all specifications separately.

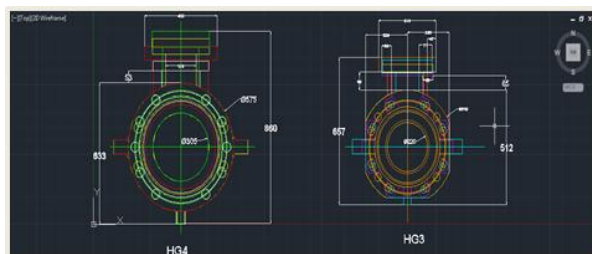


Fig 1 Overlap of HG4 and HG3 casing

We design few fixture as per requirement like shown below but there is some problem in tool layout or manufacturing process or capacity of stable work piece. So few solutions are cancelled but we still work on other. We want to save their time so design a fixture in that only clamp change but the work piece one side and flange manufacturing with one setup and remaining side manufacture in other setup. But we didn't find any perfect solution for two setups. Now we are designing for three setup which will save their time but our aim is to design the fixture for two set-up only once three set-up is properly designed we are going to reduce one set-up from it according to their requirements.

Just one problem while designing fixture that is milling on feet, cancelled some of the solutions. Other operations are done very properly but while milling the tool layout touches to clamping device. After that, design of fixture with internal clamping is consider. Also there is slot give to fixture for flange side, so that while machining flange the tool will not touch to fixture. Analyze the design with the tool layout; the tool is not while machining any operation.

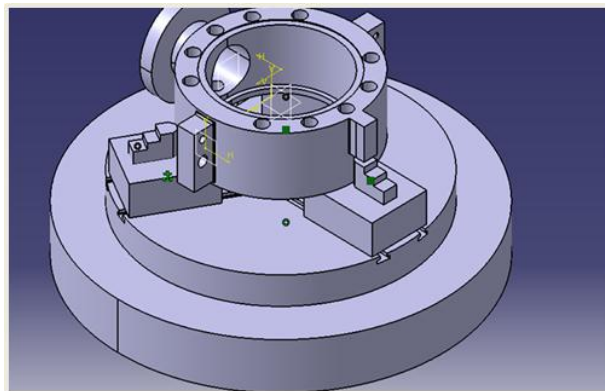


Fig 2 One of the trial Solution of fixture with HG4

For locating that fixture on table, the 50o5 diameter is padded below the base of fixture larger diameter. Because of that fixture fitted on table at center. The three jaw internal clamping is selected from the standard data from Sandvick standards on the basis of diameter of product and weight of product. The chuck fixed on fixture with the help of nut and bolt arrangement. The design of that fixture is as shown below.

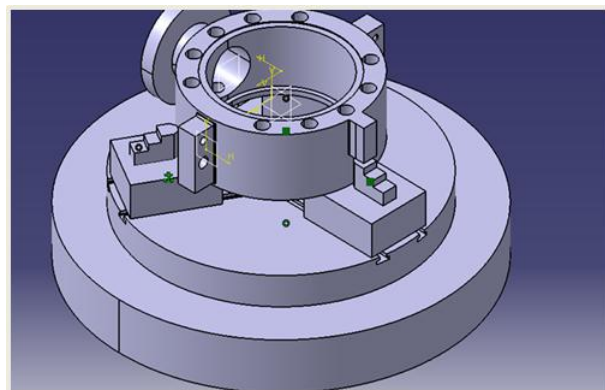


Fig.3 Design of assembly of 3-Jaw chuck & fixture

4. Result analysis and discussions

For calculating different forces we used different standard data handbook and design manual. We used machine tool handbook and HMT book for calculating forces.

Table 1 Calculated forces

Sr. No.	Part name	Machining Operations	Calculated force (N)
1	Flange	Face milling	240
2	Flange	Facing	238
3	Feed	Milling	320
4	Face	Facing	190

FEA analysis was carried out on fixture model we got the minimum and maximum stress values on the fixture as shown in figure as below.

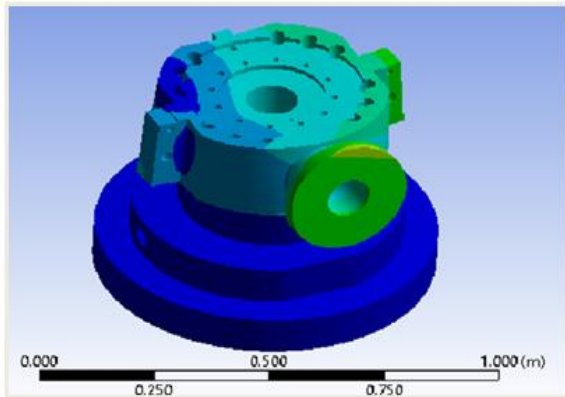


Fig.4 Equivalent Stress solution for feed milling
Minimum 1.1508e-005 MPa Maximum 3.6801 MPa

Conclusions

The efficiencies and reliability of fixture design has enhanced by the system and the result of the fixture design has made more reasonable. To reduce cycle time required for loading and unloading of part, this approach is useful. To fulfill the multi-functional and high performance fixturing requirements optimal design approach can be used to provide comprehensive analyses and determine an overall optimum design.

There is no need of changing machine for operations, so time required for loading and unloading is saved. The time required for all setup is minimum 60 minutes. So we saved maximum 40 minutes of setup of casing on machine. If product manufacturing on a single machine, there will be no need of extra labor so it reduced labor cost.

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