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Modeling and Analysis of Clamp for Brake Spider Fixture by Fem Using Ansys Software

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Abstract*: A fixture is designed and built to hold, support and locate every component to ensure that each is drilled or machined with accuracy and manufactured individually. A brake spider includes a spider body with a central opening and a slot for receiving a camshaft and bracket assembly. The brake spider is attached to axle housing via the central opening. The form to be used depends on the shape and requirement of the work piece to be machined. In the existing fixture, used for modeling brake spider component, only five components were machined per hour. In the present work, detailed study of brake spider component is carried out and design is modified to increase the productivity. The new fixture design is carried out by using CATIA V5 modeling software and it is critically evaluated for the failure of clamp component, by finite element method (FEM) using ANSYS software. This modified design is adapted in the fabrication of fixture and is tested for its productivity. It is found that there is a considerable enhancement in the productivity to seven components per hour with required accuracy.*
Key Words: *Fixture; clamp; ansys; brake spider; CATIA V5; FEM*

I. Introduction

Over the past century, manufacturing has made considerable progress. New machine tools, high-performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. Although work holding methods have also advanced considerably, the basic principles of clamping and locating are still the same. The fixtures must satisfy the conditions like reduction of ideal time, cleanliness, provision for coolant.

II. Literature survey

A brief review of contemporary research supporting this paper is presented below. The study of Dr. Yu Zheng presents a method for finding form-closure locations with enhanced immobilization capability. Fixtures are used in many manufacturing processes to hold objects. Fixture layout design is to arrange fixturing elements on the object surface such that the object can be held in form-closure and totally immobilized.

In contrast to concentration of six axis nano positioning method Dr.Patrick J. Golden tested a unique dovetail fretting fatigue fixture was designed and evaluated for testing turbine engine materials at room or elevated temperatures. Initial test results revealed interesting variability in the behavior of the nickel based super alloy specimens at elevated temperature.

K.C. Aw paper concentrates on electronic equipment used for maritime application. Simulation using ANSYS workbench software was performed to comprehend the effect of various parameters of accelerated testing performed on these waterproof enclosures. Experiments were performed to examine the correlation with simulation results.

The above mentioned strategy was applied to reduce the buckling in a part of fixture design assembly. But our main objective of the project is to increase the productivity with required accuracy.

III. Objectives

- As design of the fixture for the component cannot happen in isolation, the objective of the project also extends to the aspects like the features of the vertical machining center.
- Process planning, cycle time estimation and designing of the fixture for the brake spider component is carried out.
- Critical component of the fixture would be analyzed from stress and deflection view.

IV. 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.

- Method of locating.
- Design the clamping method.
- Design any supports required.
- Design the base required.
- Design the fixture body.

4.1 Cycle time estimation

The design of fixtures should be such that the process of loading and unloading the components takes the minimum possible time and enables on easy loading.

Table 1: Cycle time estimation

Total cycle time	6.40	minutes
Load and unload time	2	minutes
Total time	8.40	minutes
No. of components / hour	7.142	numbers

Hence, the production rate of brake spider component is seven components per hour.

V. Brake spider component

A brake spider includes a spider body with a central opening and a slot for receiving a camshaft and bracket assembly. The brake spider is attached to axle housing via the central opening. The slot is defined by an inner surface that does not completely surround the camshaft.

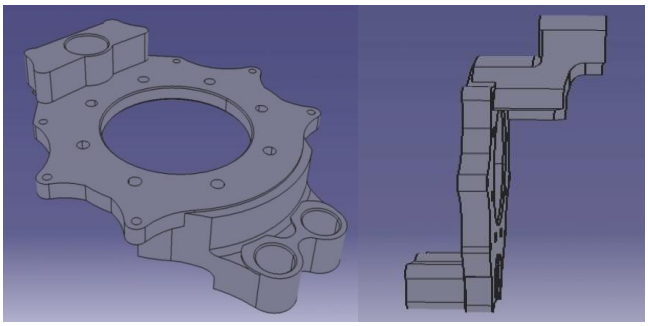

Fig 1: 3D front view and side view model of brake spider component

VI. Assembly of brake spider fixture

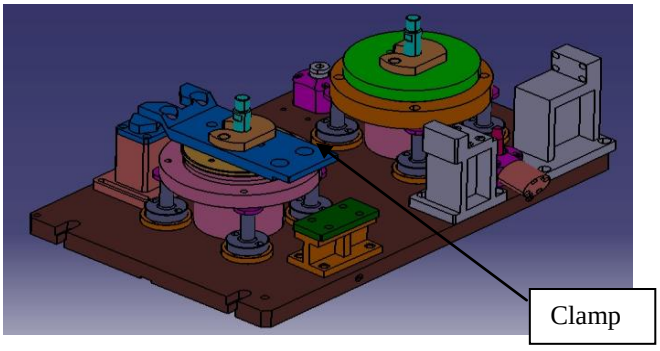

Fig 2 : 3D Isometric view model of assembly of brake spider fixture design

- Study of the brake spider component and the existing fixture in use.
- Study of the process planning: Estimation of the process for achieving the final dimensions of the components, selection of tools, tool holders, insert grades, cutting parameters and arriving at the cycle time of the component.

- Fixturing concept: As per the fixture clamp dimensions the vertical machining center is selected and conceptualized design is done by arresting six degrees of freedom by resting, locating, orienting and clamping.
- Detailed design: Assembly drawing of the brake spider fixture using CATIA V5 modeling software is carried out.
- Analysis of critical components: Static deflection analysis of key element of fixture clamp using ANSYS software.

VII. Static analysis of clamp

The procedure for a static analysis consists of these tasks:

1. Set the analysis title
2. Preferences
3. Preprocessor
    - Element type
    - Real constant
    - Material properties
    - Model generation
    - Applying boundary conditions
4. Review of result

The detailed steps in performing static deflection of base plate through finite element approach are as follows:

a. **Set the analysis title:** "Static deflection of clamp"

b. **Preferences:** Structural, Discipline: h method

c. Preprocessor:

- **Element type:** The elements chosen for the present work is SOLID-45.
- **Material properties:**

  Modulus of elasticity of steel= 2 x 10^5 N/mm^2

  Poisson's ratio = 0.3

  Density = 7800 N/mm^3.
- **Model generation:**

The model is imported from CATIA V5 and the meshing has been carried out using Ansys-mesh tool.

- **Boundary conditions:**

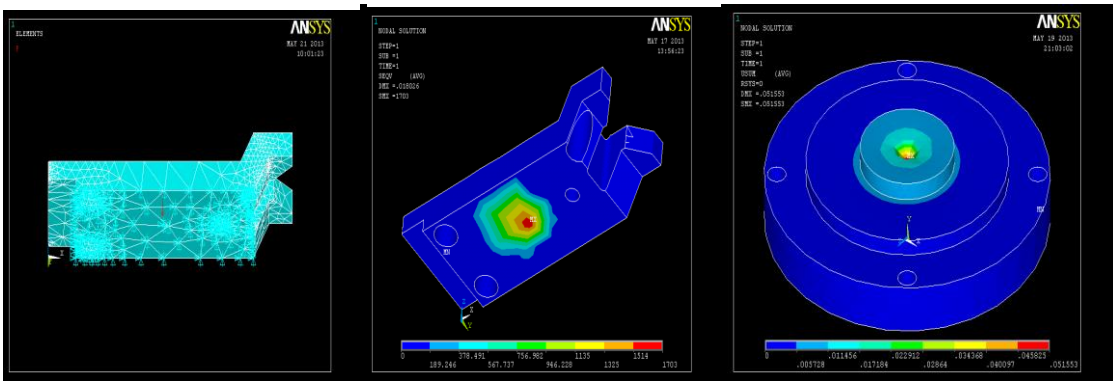

Fig 3: Boundary conditions, stress distribution and static deflection applied on clamp

A force of 6968N obtained from theoretical calculation is applied on the middle portion of clamp as shown in above Fig 3. The bottom face of the clamp is constrained to all degrees of freedom.

VIII. Conclusions

1. In the current work, the following conclusion is outlined.

- The fixture for brake spider component machining as per the customer requirements has been attempted successfully, in order to increase the productivity.

2. The static analysis of the clamp component of the designed fixture carried out by finite element method using ANSYS software is summarized as follows.

- Maximum cutting force and maximum clamping force employed for the analysis are 6968N and 20904N respectively.

- Maximum static deflection of clamp part of the fixture is found to be 0.18×10^{-05}mm and maximum stress (Von mises) is found to be 1.72Mpa. These values are within specified limits which are shown in Fig

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