Design and Simulation of Adjustable Jig for Shaft Hole Parts

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***Abstract*—The fixture is an important part of the machining accuracy in machine production. In this paper, the shaft hole parts are taken as the research object, and the adjustable drilling jigs of the hole parts are designed. According to the requirements of the six-point positioning principle of the fixture design, the positioning and clamping method of the fixture are preliminary designed, and the part design is completed. And create a 3D model of the fixture part and use ANSYS for simulation analysis. Therefore, a feasible scheme of the adjustable hole mold fixture for shaft hole part is obtained, and the machining cycle of the shaft hole part is reduced based on the effective scheme of the fixture design, and the machining precision of the part is improved.**

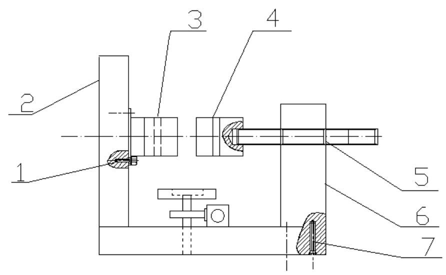
Keywords-Shaft Hole Parts; Mechanical Fixture; Analysis And Simulation

I. INTRODUCTION

In this experiment, the center hole of φ20mm-φ30mm or the end face of φ5mm-φ10mm of the shaft hole type cylindrical part of φ50mm-φ80mm is taken as the research object, and the research object should ensure the center hole in the processing. The accuracy requirements of the end face and the vertical accuracy of the center hole and the design criteria for the end face to be as symmetrical or evenly distributed as possible. In order to ensure the reasonable positioning and tightening of the research object, it is necessary to analyze the clamping force to avoid excessive positioning and clamping force to damage parts or fixtures. In addition, in order to improve the processing accuracy of the research object, it is necessary to carry out reasonable scheme design and scheme selection for the fixture, and describe the principle description, function design and structure design of the scheme to improve the research quality and significance of this experiment.

II. ANALYSIS OF CLAMPING PRINCIPLE AND SCHEME OF WORKPIECE

The φ25mm center hole or φ10mm end face of the φ60mm shaft column parts are used for milling machine. They are clamped and positioned by the V block. The parts to be processed are placed on the rotary table. And their positioning and clamping are ensured by the two V-shaped blocks (positioning V-shaped blocks, clamping V-shaped blocks) to ensure the degree of freedom of the part (satisfying the six-point positioning principle). Compared with the conventional design scheme, the scheme of this paper removes the bottom plane and the guiding component of the support, and adds a rotary table. The rotary table is characterized by the fact that the workpiece rotates through the rotating table, and then the clamping process is performed. This will lead to a higher position accuracy of the end face. More importantly, it can also reach a better versatility of the fixture, which will greatly reduce the processing time and brings a higher processing efficiency.



1-Screw, 2-Vertical steel plate, 3-V-Shaped block (Positioning), 4-V-Shaped block (Clamping), 5-Drive rod, 6-Vertical steel plate, 7-Countersunk head screw

Figure 1. Schematic diagram of fixture design

III. MECHANICAL CALCULATION OF KEY COMPONENTS OF THE FIXTURE

A. Clamping force calculation

Theoretical clamping force of the V-shaped block to the part during machining:

$$F = F_z \times K$$

In the equation:

F -Theoretical clamping force

F_z-Main cutting force

K -Safety factor

$$K=k1\times k2\times k3\times k4$$

In the equation:

K1 -General safety factor

K2 -Processing state coefficient

K3 -Tool passivation cutting factor

K4 -Intermittent cutting factor

Look up table:

k_1=1.7，k_2=1，k_3=1.4，k_4=1.2.

So K =1.7*1.4*1*1.2≈3

F =2369*3=7107N

From the above calculation, the clamping force is 7107N。

B. Calculation of the support shaft of the rotary table

Because the rotation of the rotary table is performed under manual operation, the torque received by the shaft is negligible. However, the shaft cutting force generates less torque to the shaft during the machining of the workpiece. The material of the shaft is selected as 45 steel.

Check the table to allow the use of torsional shear stress $[\tau_T]$=40Mpa;

Check the hardness of the watch HRC55;

Calculation of the minimum diameter of the shaft:

$$\tau_T = \frac{T}{W_T} \leq [\tau_T]$$

In the equation:

T -Torque generated by shaft cutting force，$T = 3960N$

τ_T-Calculated torsional shear stress

W_T-Torsion section coefficient of the shaft，

Simplify and substitute data to get:

$$d \geq \sqrt[3]{\frac{3960}{0.2 \times 40}} \approx 8\text{mm}$$

According to the above calculation, the minimum diameter of the selected shaft is 10mm, and the bearing needs to be installed on the shaft. Therefore, the length of the shaft is initially selected to be 10mm, and the shaft will not be deformed under the action of the shaft force，the shaft can be determined as φ10mn6.

Since the gear has a tooth width of 48 mm, the length of the shaft section is 45 mm, and the gear adopts a transition fit, so the diameter of the shaft end is determined to be 20 mm. According to the diameter of the shaft, the mating relationship is made by the base hole, and the relationship can be determined. The shaft segment is φ20n6, and a 6×6×28 flat key is selected for the circumferential direction of the gear on the shaft.

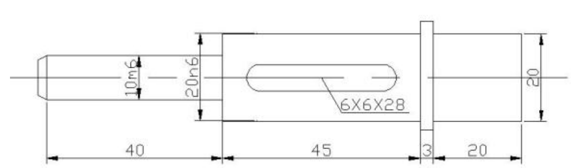


Figure 2. Mechanism diagram of the shaft

IV. ASSEMBLY AND ANALYSIS OF KEY PARTS OF FIXTURE

A. Overall fixture assembly modeling

First, place the fixture base plate horizontally, install the shaft and bearing of the rotating table vertically on the fixture base after installation, and then install the table on the top of the shaft. Install the screw rod horizontally in the screw hole of the support plate. After the screw rod and rack support plate cooperate, install the rack on the plate to complete the installation of the rotary table and fixture substrate. Fix the positioning v-shaped block horizontally on the vertical plate of the fixture substrate, place the clamping v-shaped block screw drive support plate vertically on the fixture substrate, and tighten it with screws. The screw rod of screw drive is installed on the screw hole of the vertical plate and the clamping v-shaped block and the screw rod are installed together to complete the overall assembly modeling of the clamp, The following figure:

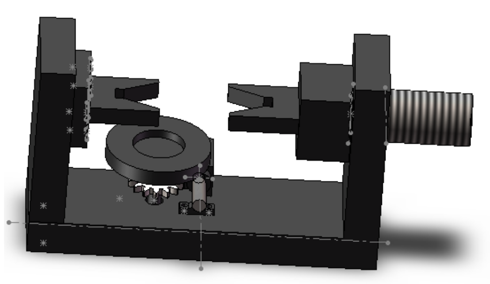


Figure 3. Fixture assembly drawing

B. Intensify the static analysis of V - shaped blocks

Clamping v-shaped block in the workpiece after the completion of positioning clamping, and the workpiece in the process of processing to be subjected to a larger main cutting force, and the machining process of the tool speed is larger workpiece will jump. The clamping v-shaped block is mainly subjected to the horizontal clamping force and ACTS with the positioning v-shaped block to offset the torque caused by high-speed rotation of the cutter. Therefore, the clamping force of v-shaped block is relatively complex. The material of the clamping v-shaped block is gray cast iron, which is subject to the horizontal clamping force of 7017N. The v-shaped block is firmly connected with the screw drive screw

By adding stress surface, support surface and force size, the analysis results are as follows:

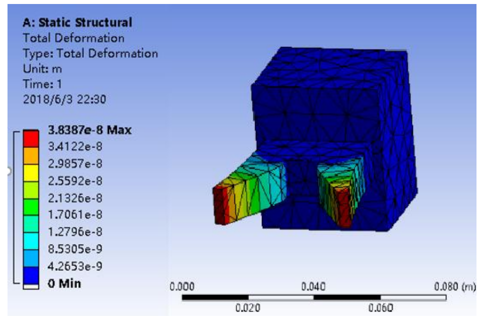


Figure 4. Total deformation of clamping v-shaped bloc

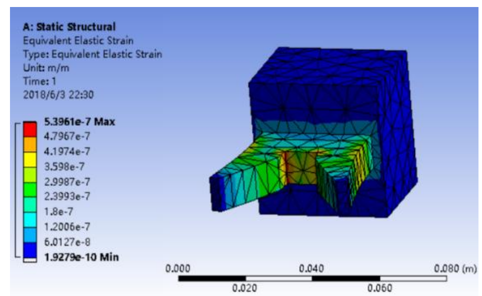


Figure 5. Strain analysis

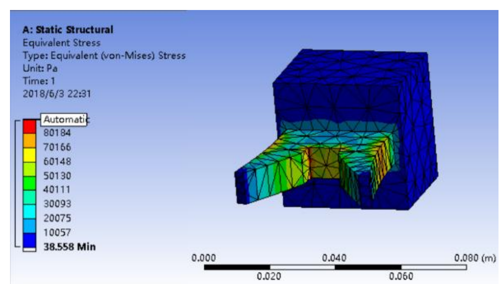


Figure 6. Stress analysis

It can be seen from the sixth order modal analysis figure that the maximum deformation of clamping v-shaped block is 3.8387×10-9mm, mainly around the "V" Angle. The maximum stress is less than the yield strength of the material, and the overall profit distribution is relatively uniform, so the parts are in good stress condition.

Modal analysis of parts is as follows:

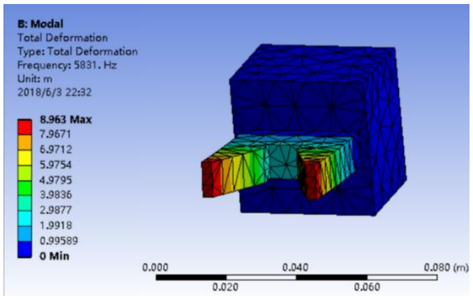


Figure 7. First-order mode

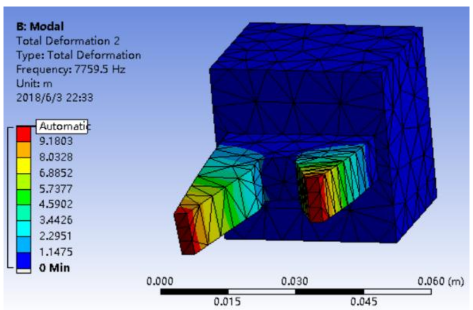


Figure 8. Second-order mode

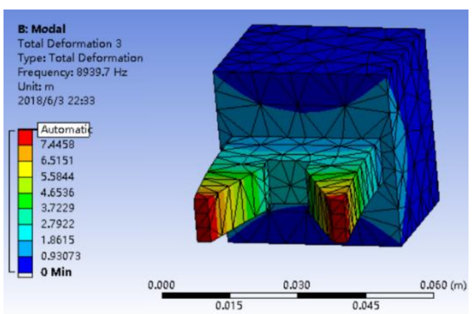


Figure 9. Third-order mode

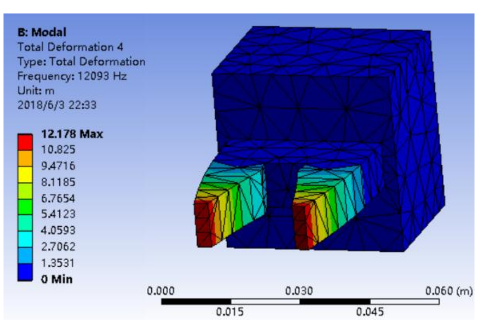


Figure 10. Fourth-order mode

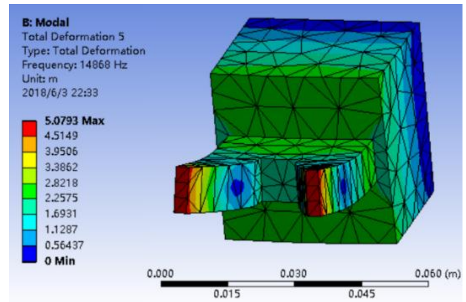


Figure 11. Five-order mode

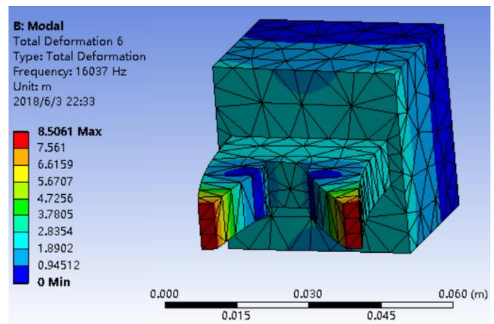


Figure 12. Six-order mode

Through modal analysis (the result is shown in the figure above), the natural frequency of v-shaped block material is far less than the frequency of dynamic load, that is, no resonance occurs. Therefore, it can be determined that the structure of the clamping v-shaped block is reasonable. Under the action of dynamic load received in the clamping process, the workpiece can still be clamped to complete processing, and the clamping v-shaped block meets the structural requirements.

V. CONCLUSION

In this paper, the design and analysis of adjustable drilling jigs for shaft hole parts are carried out. Under the premise of meeting the requirements, a new structure is used, that is, the guiding original and the low plane table are removed, and the rotating face table is used to carry out the end face. Processing. After the design was completed, the ANSYS Workbench was used to analyze the clamped V-shaped block components. Through the analysis results, the practicability and reliability of the fixture are verified, and when the workpiece needs to be rotated, the workpiece does not need to be removed and placed, and the workpiece can be rotated directly by rotating the table, which saves time and saves time, the accuracy can be guaranteed.

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