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Review on Analysis of Machine Spindle

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Abstract- The current interest in developing a manufacturing capability at the mixed scales is leading to a number of investigations concerned with the development of special purpose machine tools. Competition permanently demands the machine tool manufacturers to improve the working accuracy and the dynamical behavior of their machines while reducing both product development time and costs. The problem with most special purpose machines is the amount of vibration that is transmitted through the spindle, which affects the quality of surface finish and the dimensional accuracy imparted to the work piece being machined. Owing to the way the spindle is mounted at the end of a cantilevered structure, low resonant frequencies can occur that are easily excited. SPM is a special purpose machine exclusively used in two wheeler automobiles. The main objective of this project is to design and perform finite element analysis of the SPM. Parametric 3D model was developed using the cad software.

Index Terms- *Machine tool manufacturers, Special purpose machine, Work accuracy, Design calculations*

1. INTRODUCTION

Special purpose machines are designed and manufactured for specific jobs and as such never produced in bulk. Such machines are finding increasing use in industries. The technique for designing such machines would obviously be quite different from those under for mass produced machines. A very keen judgment is essential for success of such machines Broadly the special purpose machine tools could be classified as those in which job remains fixed in one position and those in which job moves from one station to other (transfer machines). In first case the machine may perform either only one operation or more. In the second case, the product may be Brief below, such a machine comprises a turret, on whose periphery several heads are mounted to receive and locate the components for working. The turret rotates intermittently about its central axis and is provided with fine and sophisticated mechanisms to control its motion so that before stopping, it is properly decelerated and desired positioning accuracy is attained. At stationary positions around the turret, usual mounted on a table, are the several tools and units which perform the machining operation. It is essential that all moments be completely synchronized in order to obtain desired product. All tools and units must have completed their operation and be withdrawn clear of the turret before it starts to index. Similarly the turret must index precisely and accurately and come to rest, before tools and units begin their work. The dynamics of spindle-bearing systems are highly complex because several nonlinear and Closed-loop phenomena interact with each other thermally and mechanically. Including the essential physical models required to describe the dynamic properties of spindle-bearing systems. In addition, which include? The design variables that are primarily determined at the design Stages and the operation parameters that are usually established on shop floors.

2. THE RELATIONSHIPS AMONG THESE COMPONENTS

1. The spindle-bearing system dynamic model is directly affected by the number and location of the bearings.
2. The spindle shaft dynamic model is assessed according to spindle shaft specifications such as materials and dimensions.

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3. The bearing dynamic model is assessed according to the bearing specifications, such as the number of balls, diameter of the balls, contact angle of the bearings, and the bearing preload. The bearing preload consists of the initial preload, a design variable, and thermally induced preload.

4. All dynamic models are generally influenced by operation parameters such as cooling conditions, cutting conditions, and spindle speed. Based on the proposed modeling mechanism, an exploration of bibliographic references was performed.

3. REVIEW OF SPINDLE-BEARING SYSTEM

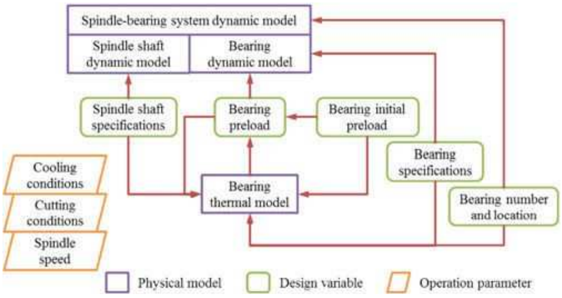

Fig. 1 bearing system

In this review, we focus on the dynamic models, regardless of their applications. To maintain conciseness, the contents are organized comprehensively. Instead of commenting on each paper individually, the dynamic models of spindle shafts and bearings are described generally and represented conceptually as functions of design variables and operation parameters by aggregating the results of related papers. However, for exceptional cases, detailed descriptions are provided. These models are reviewed in the following subsections with respect to the mentioned classification; In general, spindle shafts are the major resources of mass for spindle-bearing systems. Therefore, the mass property of spindle shaft cannot be neglected in the dynamic model of spindle-bearing systems. In the papers indicated as “Rigid” under the category “Spindle shaft” the spindle shafts were modeled as rigid beams, whereas the flexibility and This type of assumption was especially common in works focusing on bearings. In these spindle shaft dynamic models, the spindle shaft merely contributes mass to the spindle-bearing system dynamic model. However, when more reliable estimation is required or the spindle shaft cannot be treated as a rigid body, excepting mass, the stiffness of the spindle shafts must also be considered in analyzing system dynamics. Several methods can be used to model the dynamic response of a flexible shaft. The choice of modeling method must be based on the features of the shaft. Currently, the most popular approach for modeling the mechanical behavior of a spindle shaft is the finite element (FE) method because of it s capability to manage complex geometry and boundary conditions, and the calculation approaches for solving the finite element system equations are no more critical when using modern powerful computer processors.

4. DESIGN OF SPINDLE-BEARING SYSTEMS

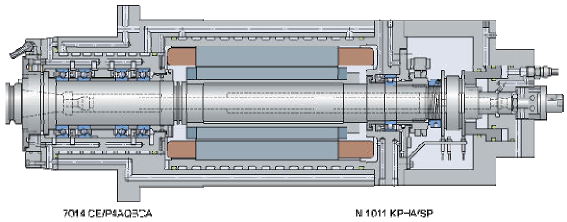

Fig.2 spindle housing

This section first summarizes the research results of reviewed literature related to the design variables or operating parameters. These conclusions can be used as guidelines for design engineers. Then, the design related papers are introduced to explore the possible optimal design approaches of spindle-bearing systems. Effects of design variables or operation parameters on system dynamics Based on the literature review, the design variables of spindle-bearing systems can be categorized into the following four groups: Spindle shaft specifications, bearing specifications, number and location of bearings, and the initial bearing preload, therefore, the sample results from previous studies can be synthesized with respect to the four sets of design variables and operation parameters:

1. Spindle shaft specifications

The first-mode natural frequency increases with

• An increase in the diameter of the spindle shaft, the first-mode natural frequency decreases.

• An increase in the length of the spindle shaft, the rear end of the spindle is the optimal position for the mass insert to improve the dynamic characteristics of the spindle-bearing system. The mass of the tool has been shown to change the dynamic response dramatically, and the speed and load also affect the frequency response. The number of balls in the bearings can be of importance in the spindle-bearing dynamics and should be considered at the design stage. As the number of balls is increased, the system becomes stiffer, because a large number of balls support the shaft.

2. Number and location of bearings

- Bearing orientation significantly affects the Spindle stiffness. The key design variables of the system's first Mode and second-mode natural frequencies include the spacing between the front and rear bearing sets, and the spacing between the middle line of the two bearing sets and the free end of the cutter bearing initial preload

3. The natural frequencies of the spindle-bearing.

- System increase with an increase in the bearing Preload because of the increase in the bearing Stiffness element.

5. SPINDLE HOUSING DESIGN PARAMETER OPTIMIZATION CONSIDERING THERMO-PLASTIC BEHAVIOR

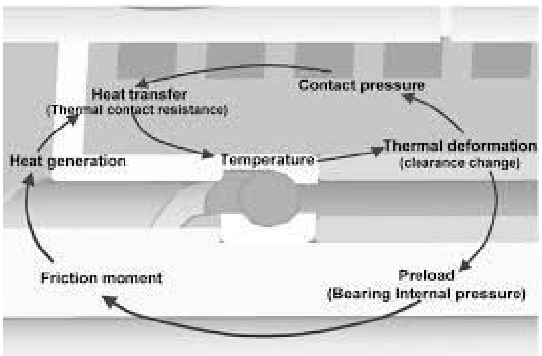

Fig.3 machine Cycle

This paper presents a simulation method for predicting thermo-elastic behaviors of spindle bearing system and an optimization procedure for housing design parameters in relation to various spindle-bearing operating and surrounding conditions such as assembling tolerance, geometric dimension, cooling condition and thermal deformation. The numerical formulation of transient thermo-elastic behaviors as a function of major spindle-bearing system design parameters is developed using the design of experiment methodology. The spindle bearing analysis program has also been suggested in this paper. The suggested modeling and optimization method not only considers thermal deformation or heat transfer, but eventually it includes the nature of thermo- elastic interaction within spindle, bearing, housing and surrounding conditions in terms of formulating the objective function describing thermoplastic characteristics such as friction moment, heat generation, contact mechanism, thermal displacement, assembly tolerance change, bearing internal clearance and spindle stiffness change and the dynamically changing operating conditions of the spindle.

6. DYNAMIC ANALYSES AND DESIGN OPTIMIZATION OF HIGH-SPEED SPINDLE-BEARING SYSTEM

High-Speed Machining (HSM) is widely used in the manufacturing industry. However premature failure without alarming signs leads the development of spindle technology to be strategically critical for the HSM implementation. This paper presents software package using Matlab for dynamic modeling and simulation of HSM spindle. It has been developed for industrial use and is composed of several modules. First a design module allows elaborating a Finite Element Model (FEM) on the basis of a dedicated rotor beam element. A readjustment module allows tuning specific material properties such as Young modulus, shear modulus and damping coefficients in order to fit model results to the experimental frequency response function.

7. THE SPINDLE STRUCTURAL OPTIMIZATION DESIGN OF HTC3250μN CNC MACHINE TOOL BASED ON ANSYS

The optimization of spindle has important significance. The optimization method based on ANSYS is introduced and spindle mathematical mode of HTC3250μn NC machine tool is given. By scanning of design variables, the main optimized design variables are determined. The single objective and multi-objective optimizations are done. In the end, the main size comparison of spindle before and after optimization is given.

8. CONCLUSIONS

We have seen from the literature review that, every machine or SPOM has its own spindle deign according to the design and application analysis of machine. Spindle design based on the various parameters like bearing mounting, pulley mounting, etc. We are doing load analysis on spindle.

9. REFERENCES

[1] H. L. Xie, H. M. Guo, Q. B. Wang, Y. X. Liu, "The Spindle Structural Optimization Design of HTC3250μn NC Machine Tool Based on ANSYS", Advanced Materials Research, Vols. 457-458, pp. 60-64, 2012

[2] Article in International Journal of Advanced Manufacturing Technology25 (11):1061-1070 · June 2005, s-m lee

[3] Dynamic Analyses and Design Optimization of High-Speed Spindle Bearing System Advances in Integrated Design and Manufacturing in Mechanical Engineering II, pp 505-518, Vincent Gagnol , Belhassen C. Bouzgarrou, Pascal R ay, Christian Barra

[4] A Review on Multi Spindle Drilling Special Purpose Machine with Respect to productivity Mr. Sakate P.R.1 Mr. Jadhav A.S., Prof. Bamankar P.B.3 Miss. Jagadale A.A.4 Miss. Bhosale P.S.5 JSRD.

[5]. International Journal for Scientific Research & Development| Vol. 3, Issue 08, 2015 | ISSN (online): 2321-0613 5. Applied Mathematics and Mechanics – Springer Netherlands.

[6] Bathe K J (2007), Finite Element Procedures, 1st Edition.

[7] Jain R K (2011), Production Technology: Manufacturing Processes, Technology and Automation, 17th Edition, K H Publishers.