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Operational Assessment of Machine Tool Vibration Resistance

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Abstract

The issues of vibration resistance of machines evaluation in a production environment based on experimental determination of dynamic characteristics of spindle units in the original software environment, of identification of model parameters according to experimental results and evaluation of the actual stiffness of the supports of the spindle have been reviewed The results of studies of several CNC lathe group are presented. Recommendations for improving rigidity of the spindle bearings are given.

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Keywords: Vibration; vibration resistance; stiffness; dynamic behavior; simulation; spindle assembly; the condition of the bearings

1. Introduction.

The problems associated with vibration when machining on metal-cutting machine tool, i.e. the problem of vibration resistance, arise in any enterprise, operating metal-cutting equipment. There comes a time when the machine stops normally cut the workpiece, there are intense vibrations even at low cutting depths [1-3]. Because of this on the CNC machines necessary to introduce a correction into the program to change modes of processing, productivity falls. Often loss of vibration resistance occurs due to the wear of spindle bearings, due to the reduction of preload in the bearings, due to the decrease in the stiffness of the bearing system. The systems of operative diagnostics and monitoring of the mechanisms and machine parts are recommended [4-7].

Sometimes even new machines have low vibration. This is one of the companies imported two identical modern lathes CNC. One worked well, met all requirements, and the other lost the vibration resistance, especially on the boring operations and lateral turning [8].

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The main indicator of the dynamic quality of the machine [1] is its amplitude-frequency characteristic (AFC). Currently developed sufficiently effective methods and means of measurement of amplitude-frequency characteristics, including the production environment. However, the question remains about the interpretation and evaluation of measured frequency response in the absence of any normative documents.

A method is proposed for estimating experimental frequency response by matching with a certain evaluative characteristic obtained by calculation for the model of the machine.

2. The methodology of the study.

We show the application of this method on the example of the lathe machining center. Numerous previously conducted dynamic studies [8, 9, and others] show that the greatest influence on the frequency response of a lathe has its spindle Assembly. Therefore, for simplicity we will consider the computational model of spindle Assembly.

In a production environment were carried out to measure the frequency response of the two lathes machining centres and one of the same model. One worked without failures and censures with a maximum load of about 7 years, let's call it machine "A". Another worked for a little over a year, let's call it machine "B". To the work of both machines recently appeared to claim: in finish turning at maximum speed (2500-3200 rpm) there was a noise and vibration, significantly reduced vibration free depth of cut, a drop of vibration. Such problems associated with vibrations when cutting, arise quite often, but these cases are notable for the fact that you can compare two same design of the machine, which are operated under the same conditions and with the same load, which would seem to be very similar in production values, but they vary greatly.

Spindle unit (SU) of lathes is a rotor on two supports (Fig. 1): in the front post double row radial roller bearing in combination with axial-radial ball bearing; a rear bearing double-row radial roller bearing.

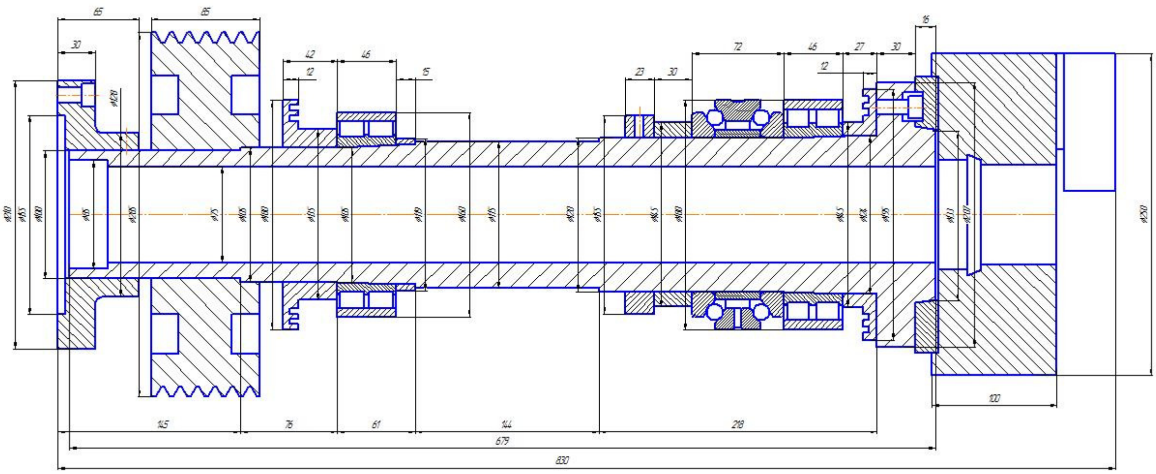

Fig. 1. Spindle unit of machine tool

Experimental studies of both machines was carried out in identical conditions by the method of pulse loading with a torque hammer and measuring the response on this effect [10-12]. Were obtained the amplitude-frequency characteristic (AFC) of the elastic system spindle Assembly at blows on the workpiece near the Cams and measure the elastic response of the sensor of absolute vibrations (accelerometer) at the same point. Amplitude-frequency characteristics of the SU of two machines (Fig. 2) show that the natural frequency of the SU "A" machines below (316 Hz) than the "B" (380 Hz). Dynamic compliance on the natural frequencies from the "A" machine is almost 1.5 times higher than the "B" (5,14 and 3,44 units, respectively), i.e. the "A" machine and has a lower frequency, and more compliance.