ABOUT THE MESUREMENTS FOR NATURAL VIBRANT FREQUENCIES OF MACHINE TOOL SPINDLE USING EQUIPMENT NI 4772 WITH SMART OFFICE SPECIFIALIZED SOFTWARE

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Key words: Mesurement frequencies, dynamic calculation**;** natural vibration; machine tool spindle; specifialized software.

Abstract. The article introduces briefly the methods, equipments to measure vibration and measured results to define natural vibrant frequencies of machine tool spindle using equipment NI 4772 with Smart Office specialized software. These results were compared with calculated results using finite element method and to evaluate measurement accuracy.

1. Introduction of the principle of general measurement instruments and equipment NI 4772 and software Smart Office [2] , [5] , [6]

Principle diagram of test and analysis for a sample is described in Figure 1 .

The contents of this section include:
- System excitation;
- Force and displacement converters;
- Frequency response analyzer.

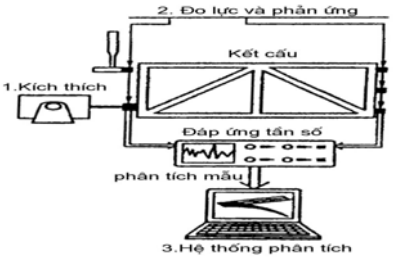
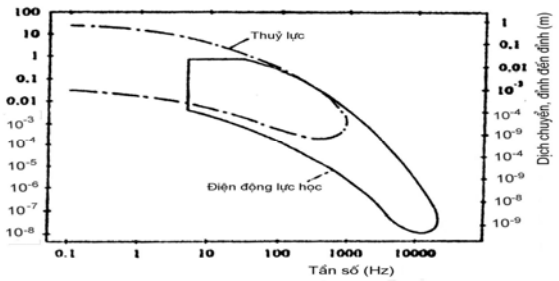


Fig. 1. Sample analyzing diagram

1.1. Excitation system

1.1.1 Fixed excitation system

The fixed excitation system is usually placed on the ground (or on the frame of the machine) and attached to the test structure. This type is often drived by hydraulic electric power. Its main characteristic is the power level, displacement level and frequency ranges. Figure 2 below shows the working ranges of two major agitators and the Table 1 summarizes some typical characteristics of a hydraulic vibration generator.



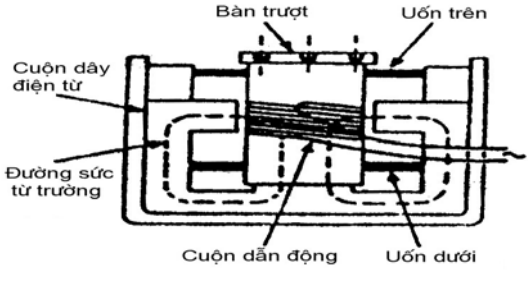


Fig. 2. Working ranges of two vibration generators

Fig. 3. Basic structure of electric vibration generators

Table 1. Typical characteristics of hydraulic vibration generator

Dynamic force [N]	5.000	to	100.000
Total stroke [mm]	25	to	25
frequency range [Hz]	0-10000	to	0-200
Dimensions [mm]	125x100x125	to	350x250x520
Weight [kg]	5	to	40

Basic structure of electric vibration generator (see Figure 3) and some typical characteristics of wide range of electric vibration generator are given in Table 2.

Table 2. Typical characteristics of electric vibration generator

Dynamic force [N]	8	to	1800
Total stroke [mm]	6	to	19
frequency range [Hz]	0-10000	to	0-4000
Dimensions [mm]	75xΦ76	to	570x570x700
Weight [kg]	1,1	to	250

Another form of vibration generator comprises two identical eccentric wheel rotating in opposite directions, as described below (see Figure 4).

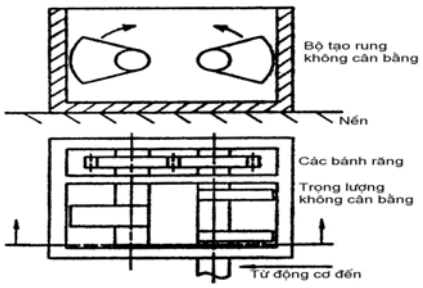


Fig. 4. Basic structure of the eccentric vibration generator

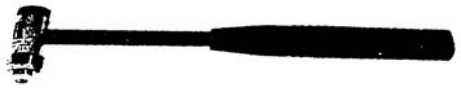


Fig. 5. Force Excitation Hammer

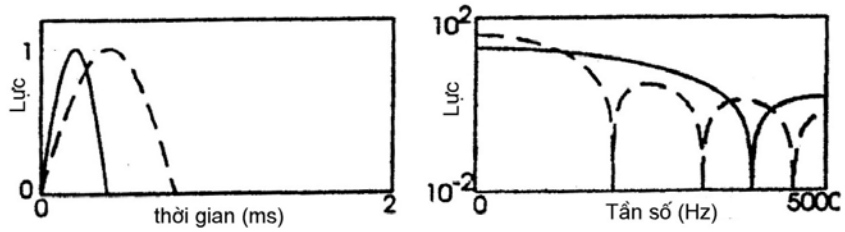
1.1.2. Independent excitation system

This system is not fixed to the test structure. Meanwhile, the excitation system is not affected by dynamic effect by the tested subject. The most common example is the form of a testing hammer. Some other examples of this kind are electromagnetic or acoustic exciters when the load is abruptly imbedded or disconnected.

Figure 5 illustrates the force excitation hammer.

Energy level and frequency range is determined by the force of the hammer, the weight of the hammer, hammer end hardness and the position of the impact point on the structure.

Figure 6 shows the relationship between the signal of the hammer and the frequency of them.



A special independent excitation system is in the form preloading structure, for example by stretching or pulling strings, and then suddenly loosening them. This technique is often applied for the structure with tower type.

1.2 Force and displacement converters

Most converters are used when testing and analyzing samples based on piezoelectric crystals on the principle that the crystal deformation is proportional to the force acting on the crystal.

Below is the diagram of piezoelectric converter (see Figure 7) and its specifications (Table 3).

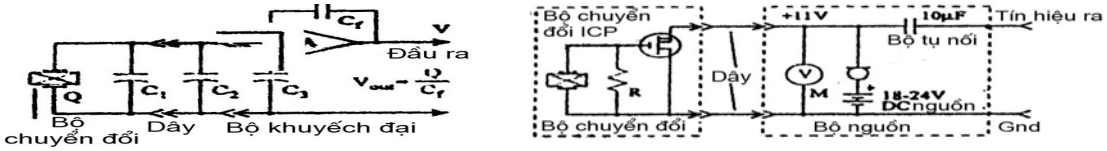
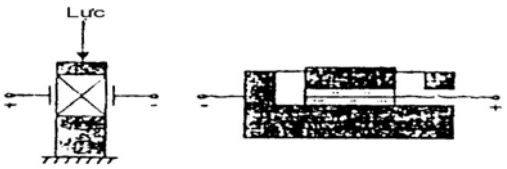


Fig. 7. Diagram of piezoelectric converter

1.2.1. Force converter

Diagram below gives the principle of the piezoelectric converter (see Figure 8), the accelerometer response (Figure 9) and the main characteristics of the piezoelectric converter is shown in Table 3.



\Fig. 8. Principle of a piezoelectric converters

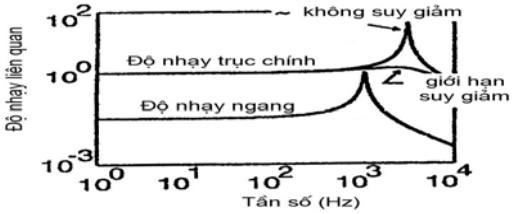


Fig. 9. Typical response horizontal response of the accelerometer

Table 3. Main characteristic of the piezoelectric converter

Maximum and minimum force [N]	5-10	to	10-250.000
Resonant frequency [kHz]*	300	to	25
Sensitivity [mV/N]	500	to	25
Weight [g]	8	to	550

** Measured at no load converters.*

1.2.2. The contactless displacement converter

For the structure to be measured with the weight and size are very light and small, a contactless measurement is required. To measure the displacement of the conductive material surfaces, it must be based on the contacting induction principle.

Figure 10 introduces the principle of vibration measurement instrument in Laser type.

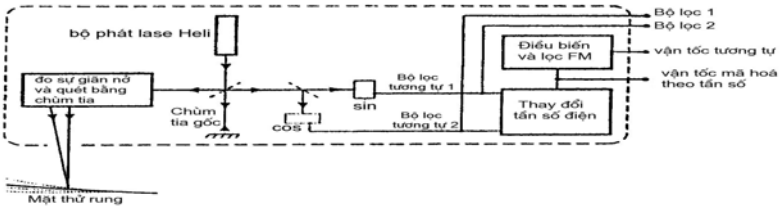


Fig. 10. Principle of vibration measurement instrument in Laser type

2. Measuring and determining the particular oscillation of lathe spindle by equipment NI4412 and software Smart Office [1] , [6]

In part 1, some principle diagrams, methods and general vibration measuring equipments relating to equipment NI4412 and the following vibration measuring software are given.

Software Smart Office 2.4 and measurement equipment NI 4412 are created in Belgium, which are used for managers, engineers, technicians and staff involved. The database, analyzing data and all reported data are in standardized formats.

Smart Office is standardized in units, operating system Windows NT®. The operating system Windows NT® is very easy to use.

2.1. Measuring arrangement and measurement point selecting

The following diagram describes measuring arrangement in Figure 11 (spindle are located on two half bearings clamped by balancing machine MC9 - 0). This spindle are in the same size and structure of the spindle needs to be examined.

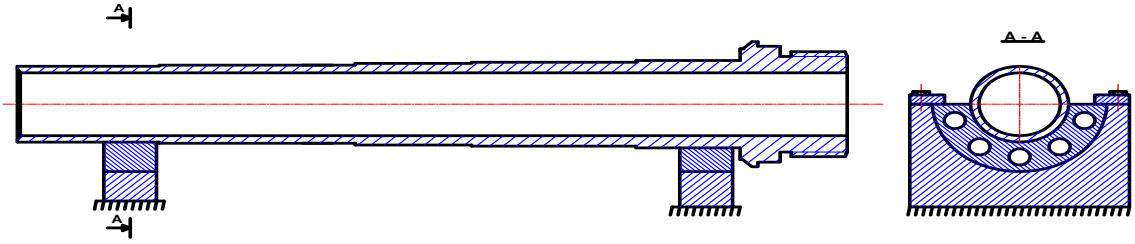


Fig. 11. Main spindle measurement arrangement

The following figure presents the measurement point selecting. These selected points are positions to be impacted by hammers to create vibration (Figure 12)

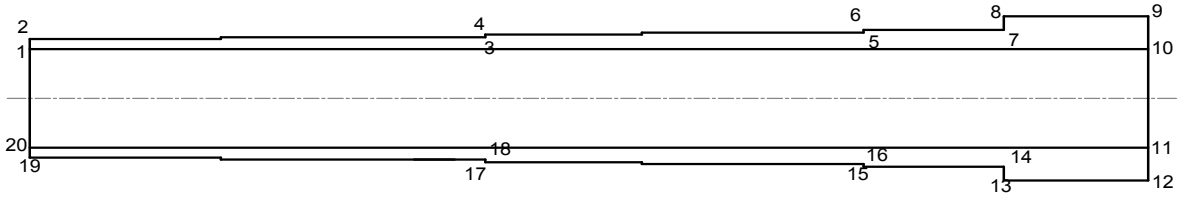


Fig. 12. Measurement point selecting diagram

The selected measurement points are the points allocated in the sections of different size. They are relatively typical points, representing the shape and structure of the shaft. On a section, 20 points are selected (see Figure 13). When testing to determine the particular vibration pattern, 06 sections are selected spaced in 30^0 as shown in Figure 13.

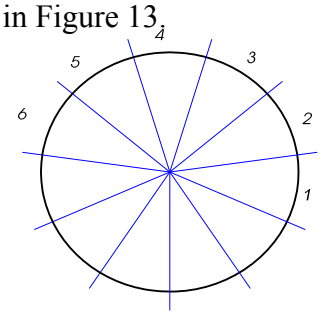


Fig. 13. Six evenly spaced measurement surface

Thus, the main spindle is measured in a total of 120 points around, forming the spindle grid.

2.2. Measurement order

Some pictures of measuring process defining particular vibration of the spindle in picture 14.

Fig. 14. Some pictures of measuring process defining specific vibration of the spindle

Picture of spindle grid and measuring arrangement with 120 points are shows in Figure 15 and Figure 16.

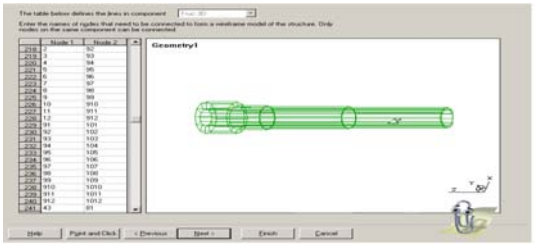


Fig. 15. Main spindle grid

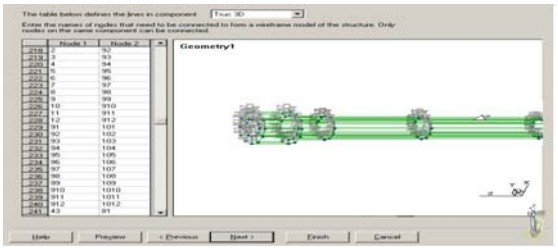


Fig. 16. Measurement arrangement with 120 points

2.3. Vibration measurement results

Vibration measurement results are showed in Figure 17 bellow [6]:

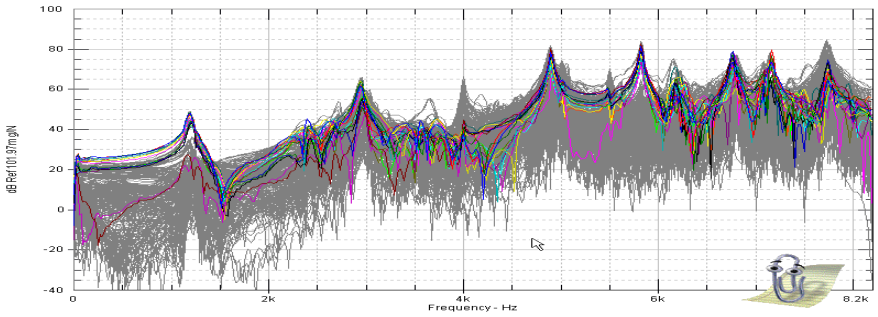
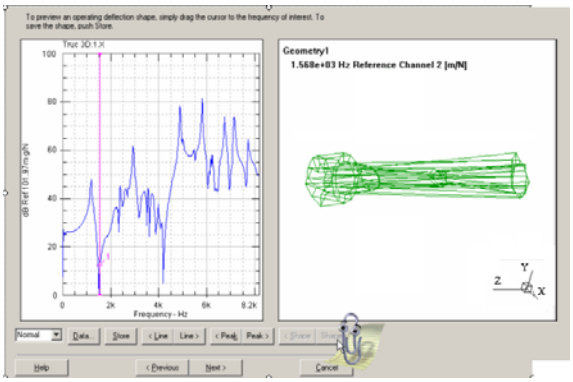
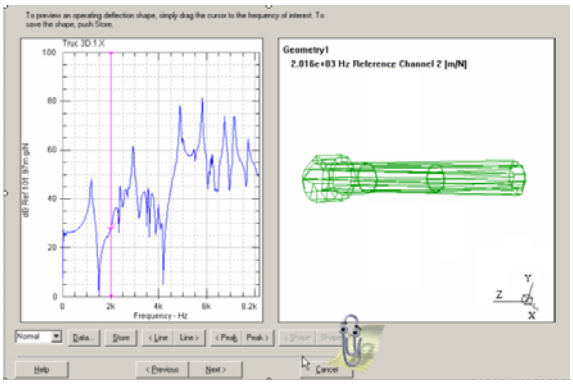


Fig. 17. Vibration chart of the spindle (including 120 points)

Types of particular vibrations correlated to particular frequency in Figure 18.



The 1st particular vibration corresponding to Hz=1568



The 2nd particular vibration corresponding to Hz=2016

Fig. 18. The particular mode of vibration corresponding to different frequencies

3. Comments and evaluation

- This is the applicant research, using equipment NI 4772 and software Smart Office 2.4 of Belgium to measure and determine its own oscillation (particular frequency and vibration pattern) of lathe T18 spindle.

- A very good ability of the device and software are identified a very wide range of particular frequencies up to 8 kHz and there are so many types of spindle particular vibration patterns.

- Creating free vibration to measure particular vibration is not so difficult by testing hammer or excitation machines or many common objects, which are popular in engineering study. So the test is quite easy. However, the accuracy of measurement results depends heavily on the selection of measurement points, the number and position of measurement point and allocating the points (measuring arrangement).

- The measuring and determining of particular vibration were performed on the lathe spindle of Hanoi Mechanical Company at 120 points which form the main grid. The measured results of particular frequencies have changed compared to the values calculated at 10 initial frequencies +1.16 % to - 3.25 % (the calculation detail for these particular vibration values of the spindle is not present in this article) . The deviation values are acceptable in the researching.

- Measured results of the first 10 frequencies are as follows:

1.568; 2.016; 2.512; 2.976; 3.472 (Hz);

3.984; 4.594; 5.040; 5.525; 6.000 (Hz).

4. Reference

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