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EXPERIMENTAL ASSESSMENT OF THE MILLING MACHINE COLUMN BEFORE REMANUFACTURING

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Abstract: *The purpose of the experimental research presented in this paper was to identify the maximum rotation that could be supported by the column of the FUS 25 milling machine, which is to be remanufactured. In order to achieve this intend, the transfer function of the FUS 25 milling machine elastic structure was determined and the natural frequencies were identified and we calculated the critical speeds for which the structure element of the analyzed machine could enter into a state of resonance.*
Key words: *column, frequencies, resonance, remanufacturing, vibration,*

1. INTRODUCTION

Continuous real structures have an infinite number of degrees of freedom and an infinite number of modes of vibration. During experiments, due to time and cost constraints, FRF measuring is carried out for the degrees of freedom requested for the precise definition of the natural vibration modes, within the measuring frequency range intervals. In modal testing, frequency response functions measurements are made under controlled conditions, where the structure of the analyzed technologic equipment is artificially excited. The measurement of the frequency response function determines the natural frequency values that are the calculation basis of the speeds at which the machine tool can enter the zone of resonance (Ispas, 2008).

2. RESEARCH COURSE

The continuous real structures have an infinite number of degrees of freedom, and an infinite number of vibration modes. Using certain experimental research techniques, a mechanic structure can be put in a vibration condition using a sustained oscillatory movement.

Fig.1 presents the algorithm of the experimental research.

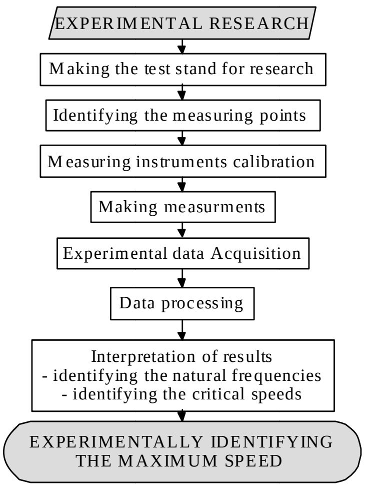

Fig.1. Algorithm of the experimental research

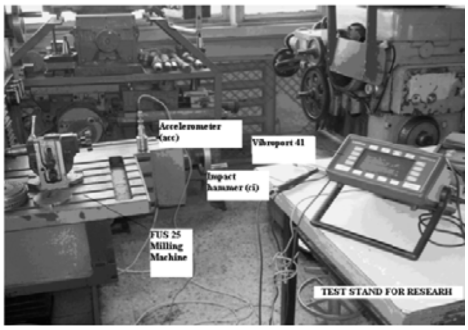

Fig. 2. FUS 25 Tool-shop milling machine

Based on this algorithm, a test stand for the requested measurements was made for identifying the natural vibration modes of a tool-shop FUS 25 universal milling machine (fig.2). The measuring points of the frequency response were chosen to obtain information regarding the dynamic behaviour mode of these structure elements which are appropriate to be remanufactured.

3. TEST STAND FOR RESEARCH

The basic component of the test stand used in our experimental research is the FUS 25 tool-shop milling machine.

The following instruments were used for making the experimental research (Schwarz, 1999):

- Impact hammer (ih) with a load cell attached to its head to measure the input force.
- Accelerometer (acc) to measure the response acceleration at a fixed point and direction.
- *FFT (Fast Fourier Transform)* analyzer with two or four channels to compute FRF (*Frequency Response Function*).
- VIBROEXPERT CM – S40 processing software, for the data processing and identifying the modal parameters.

4. MEASURING METHOD

For the modal test, the measurements of the frequency response functions are carried out under controlled conditions, where the structure of the analyzed technologic equipment is artificially excited (Zapciu & Bisu, 2007).

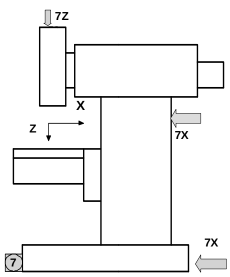

Fig. 3. The location of the exciter and receptor in case of the measurement no. 7

Measurement no.	Accelerometer location	Impact hammer location	Impulse on
3	3Yacc	3X ih	column
		3Xih	top slide
		3Yih	column
5	5Xacc	5Xih	column(backside)
		5Yih	column-on side
		5Zih	the top slide
7	7Zacc	7Xih	column
		7Xih	the base
		7Zih	the top slide

Tab.1. The location of the accelerometer and impact hammer on the column

The graphic presentation of the excitation points and the accelerometer response recording points are shown in Fig. 3 (for measurement no.7) and summed up in Table 1.

The technologic equipment that would be remanufactured, are mostly non-operational. More than that, the remanufacturer determines the parameters of the newly remanufactured equipment at his headquarters, when the equipment is non-operational, and rarely at the location from which it is sent to be remanufactured.

If the measurements were made with the equipment in a certain operational regimen, these results would be affected by all the factors which influenced the machine-tool dynamic behavior.

The data acquisition was carried out without a previous preparation of the machine tool, as the inspection of the play between the component elements, the verification of the foundation fitting screws pressing, and the inspection of the structural elements fitting screws, etc.

An excitation was induced in the system with the impact hammer (impulse), and the structure subsequently suffered a move (response), which was perceived and measured with an accelerometer. The excitation made with the impact hammer was produced in the beforehand fixed points, taking into account the following considerations (Daraba, 2008):

- The measurements to comprise all structure elements which are to be reused for remanufacturing.
- The most vulnerable elements of the machine tool to be assessed from a dynamic point of view.

5. MEASUREMENTS RESULTS PROCESSING AND INTERPRETATION

Based on the experimentally obtained numeric results, using specialized software, we obtained the graphs of the transfer functions, which highlighted the vibration natural frequencies of the analyzed machine-tool elastic structures.

The experimental research allows the identification of the speeds that can bring about the machine-tool in the zone of resonance.

These speeds will be annulled from the speeds domain helped by the numeric control (CNC) that will equip the remanufactured machine-tool.

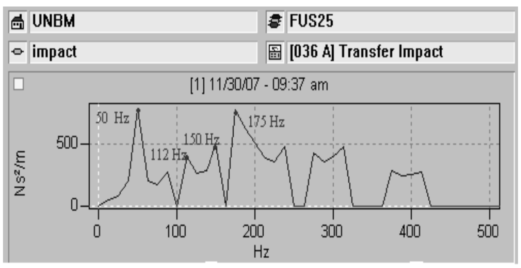

Fig. 4. Acquisition of the transfer function experimental data

Meas. no.	Acc.	Ih.	Natural frequencies [Hz] / Critical speeds [rot/min]			
3	3Yacc	3Xih	50	112	150	175
			3000	6720	9000	10500
		3Xih	50	125	-	-
			3000	7500	-	-
		3Xih	62	100	125	162
			3720	6000	7500	9720
5	5Xacc	5Xih	50	112	-	-
			3000	6720	-	-
		5Xih	50	100	137	162
			3000	6000	8220	9720
		5Zih	50	100	162	200
			3000	6000	9720	12000
7	7Xacc	7Xih	50	112	137	162
			3000	6720	8220	9720
		7Xih	50	100	162	-
			3000	6000	9720	-
		7Zih	50	112	-	-
			3000	6720	-	-

Tab. 2. The natural frequencies and the critical speeds of the column

Analyzing the transfer function graphs of Fig.4, the natural frequencies of every measurement were setup and represented on respective images.

The critical speeds of the milling machine were calculated, commencing from the experimentally determined natural frequencies, and the results are shown in Table 2.

6. CONCLUSION

The column is the component of the elastic structure which limits the maximum speed of the spindle, for the new technologic equipment obtained by remanufacturing.

This experimental research ascertained that the FUS 25 universal milling machine, which by manufacturing had the maximum speed of 2200 rot/min, could increase it up to 6000 rot/min, following the remanufacturing process.

The natural frequencies within the range of the operational frequencies of the surveyed technologic equipment were analyzed in this experimental research.

Analyzing the natural vibrations modes of the system, relevant conclusions were obtained about the dynamic condition of its structure. According to the presented algorithm, the testing is quick, suitable, and cost efficient.

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