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MEASURING THE AMOUNT OF MECHANICAL VIBRATION DURING LATHE
PROCESSING

MERANIE VEĽKOSTI MECHANICKÉHO KMITANIA PRI SÚSTRUŽENÍ

Abstract

The article provides basic information regarding the measurement and evaluation of mechanical vibration during the processing of material by lathe work. The lathe processing can be characterized as removing material by precisely defined tools. The results of the experimental part are values of the vibration acceleration amplitude measured by the piezoelectric sensor on the bearing house of the lathe. A set of new knowledge and conclusions is formulated based on the analysis of the created graphical dependencies.

Abstrakt

Článok poskytuje základné informácie o meraní a vyhodnocovaní mechanického kmitania pri obrábaní materiálu sústružením. Sústruženie možno charakterizovať ako odoberanie materiálu presne definovaným nástrojom. Výsledkom experimentálnej časti sú namerané hodnoty amplitúdy zrýchlenia vibrácií pomocou piezoelektrického snímača na ložiskovom domci sústruhu. Na základe analýzy vytvorených grafických závislostí je sformulovaný súbor nových poznatkov a záverov.

Keywords

Lathe processing, mechanical vibration, vibration acceleration amplitude, frequency, frequency spectrum.

1 INTRODUCTION

The article provides basic overview of the vibration diagnostic, as a method which serves for early diagnosis of the damage, through the analysis of measured vibrations on given device. The bases for the diagnostic evaluation methods are especially objective and qualitative data about the monitoring system, which we gather either by a one-time measurement or permanent monitoring. Early discovery of the arising defect has a great influence on the fluency and effectiveness of the production. In our case one of the three characteristic values was used for the diagnosis of the mechanical vibration, namely the acceleration of the vibration. The vibration is an undesired occurrence during processing; therefore one needs to deal with this topic more frequently [1 -4].

The article observes the amount of vibration on the bearing house of a turning lathe selected in advanced through the change of the rpms and the thickness of the removed material in frontal type of lathe processing.

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2 CONDITIONS OF THE EXPERIMENTS

The experiments were performed in the laboratory of splint processing on alloy type construction steel of the type STN 11 503 class 11. The Fig. 1 displays the material before and after the processing. Six independent measurements were performed, split into three experiments. Initial constant and changing parameters under which the experiments were performed are stated in Table 1 [6].

Tab. 1 Conditions of the experiments

	constant parameters	changing parameters		output
	type of material	the reduction of the material	motor speed	
1. experiment	11 503	0 mm	800 a 1200 rpm	vibration on the bearing housings
2. experiment		1 mm	800 a 1200 rpm	
3. experiment		2 mm	800 a 1200 rpm	

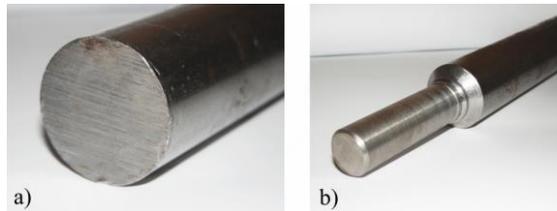


Fig. 1 Material before and after processing

3 SPECIFICATION OF THE TECHNICAL SYSTEM DURING THE MEASUREMENT AND EVALUATION OF THE VIBRATION

A piezoelectric sensor of the type 4507B-004 from the Brüel & Kjaer Company was used for the monitoring of the frequency analysis of the vibration, which was attached to the bearing house of the lathe TOS SV 18RB through magic glue (Fig. 2). The piezoelectric sensor of the vibrations monitors the vibrations during the processing in the direction of the lathe processing axis. The data collector records the acceleration of the vibration signal and integrates it with the speed of the vibration signal [6].

Vibration acceleration amplitudes recorded in the axis of the lather processing in this way are written into the memory of the Compact DAQNI 9233 device of the National Instruments Company and are evaluated in the frequency spectrum through the means of a quick Fourier transformation. This allows determining the quantity of the harmonic frequencies in the monitored signal. The evaluated signal can then be immediately observed on a portable computer thanks to the SignalExpress software. The SignalExpress program contains several functions necessary for the proper evaluation, recording and analysis of the measurements [6].



Fig. 2 Attachment of the vibrations sensor on the bearing house of the lathe

4 MEASURED VALUES OF THE EXPERIMENTS

The vibration signal measured during the processing and during the time period is transformed through the means of a quick Fourier transformation to the frequency spectrum in the range 3.0 – 10.0 kHz. The graphic dependencies of the vibration acceleration amplitude course changes depending on the frequencies are evaluated together for 800 and 1200 motor rpms. The vibration acceleration amplitude course changes for frequencies of 800 and 1200 motor rpms and material removal of 2 mm are graphically displayed as an example in Fig. 3.

Graphical dependencies of the vibration acceleration amplitude and vibration frequencies for 800 and 1200 rpm without load and with material removal of 1 mm have been also analogously displayed.

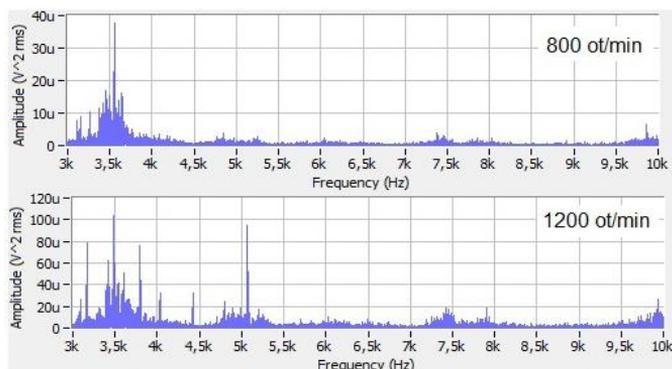


Fig. 3 Graphical dependency of the vibration acceleration amplitude on the frequency with material removal of 2 mm

Based on the graphical dependencies of the vibration acceleration amplitude, covers of the frequency spectrum of the vibrations on the bearing housing have been created, and based on them, comparison charts of the frequency covers spectrums for the common set of experiments have been created. Fig. 4 depicts the comparison chart of the frequency spectrum covers together for the selected examined set of spindle rotations of 800 and 1200 rpms without load. The comparison chart of the frequency spectrum covers for the motor rotations of 800 and 1200 rpms with material removal of 1 mm is depicted in Fig. 5 and with material removal of 2 mm in Fig. 6.

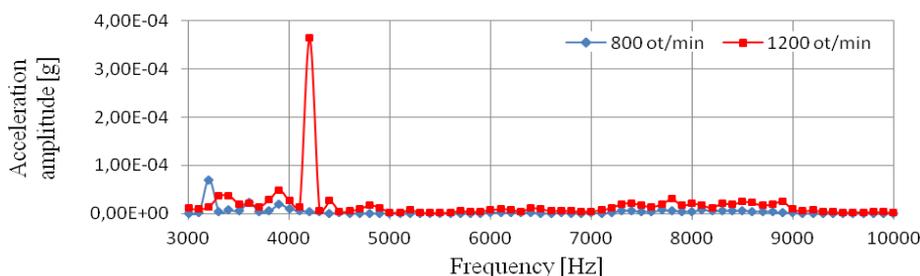


Fig. 4 Comparison chart of frequency spectrum covers without load for 800 and 1200 rpms of the motor

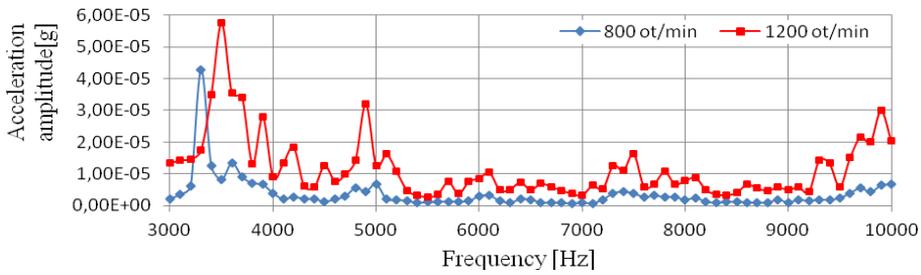


Fig. 5 Comparison chart of frequency spectrum covers with removal thickness of 1 mm and 800 and 1200 rpms of the motor

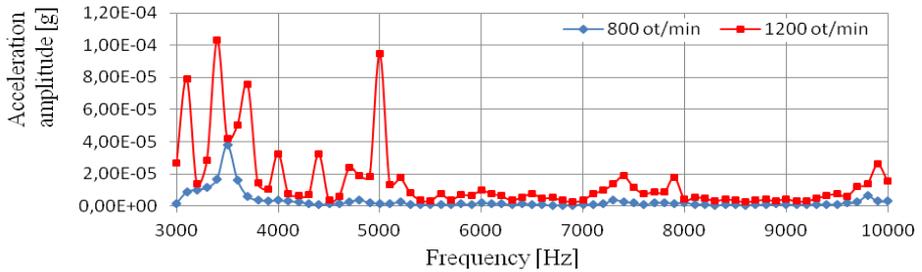


Fig. 6 Comparison chart of frequency spectrum covers with removal thickness of 2 mm and 800 and 1200 rpms of the motor

Chart of the maximum vibration acceleration amplitude values is created based on the comparison charts of the frequency spectrum covers (Tab. 2).

Tab. 2 Maximum vibration acceleration amplitude values

motor speed	maximum values of the vibration acceleration amplitudes [g]		
	1. experiment	2. experiment	3. experiment
800 rpm	$7,05 \cdot 10^{-5}$	$4,29 \cdot 10^{-5}$	$3,78 \cdot 10^{-5}$
1200 rpm	$3,64 \cdot 10^{-4}$	$5,76 \cdot 10^{-5}$	$1,44 \cdot 10^{-5}$

The results of the experiments contain also the evaluation of the comparison charts of the frequency spectrum covers in the structure independently for the two examined rpms and together for the material removal. The comparison chart of the vibration acceleration covers and vibrations frequency spectrums of the bearing house for 800 rpms and material removal of 1 and 2 mm is depicted in Fig. 7 and Fig. 8 depicts the comparison chart for 1200 rpms.

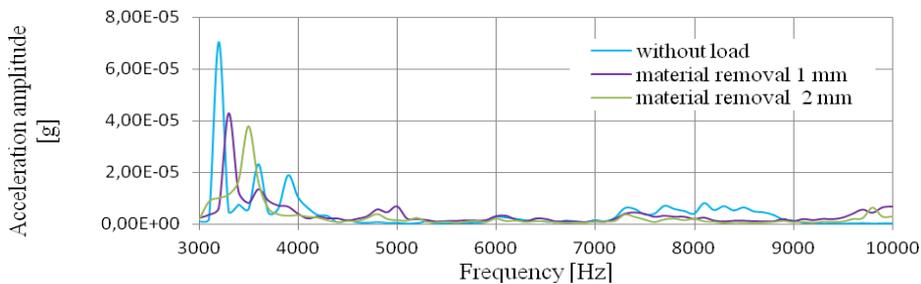


Fig. 7 Comparison chart of the frequency spectrum covers with material removal of 1 and 2 mm and at 800 rpms

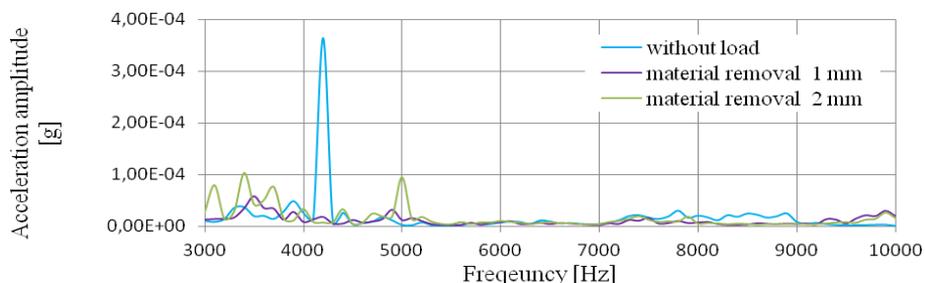


Fig. 8 Comparison chart of the frequency spectrum covers with material removal of 1 and 2 mm and at 1200 rpms

5 DISCUSSION

The article deals with the effect of lathe motor's rotations and the factor of thickness of the removed material from the processed material on creation of mechanical vibration in the bearing house of the lathe during processing and the results are new knowledge and recommendations:

- with two examined motor rotations of 800 and 1200 rpms and material removal of 1 and 2 mm, the increased vibrations values in the examined range 3,0-10,0 kHz are found in the frequency spectrums 3,0 through 5,0 kHz
- the size of the vibration acceleration amplitude without load in the comparison range reaches the highest value $3,64 \cdot 10^{-4}$ g at frequency 4,2 kHz and 1200 rpms
- with the growing numerical value of the motor's rotations without load in the examined range, the value of the vibrations accelerations amplitude increases and when compared to the 800 rpms and 120 rpms grows 80,63 %
- the size of the vibration acceleration amplitude with material removal of 1 mm in the comparison range reaches the highest value $5,76 \cdot 10^{-5}$ g at frequency 3,5 kHz and 1200 rpms
- with the growing numerical value of the motor's rotations and material removal of 1 mm in the examined range the value of the vibrations acceleration amplitude grows and when compared to the 800 rpms and 120 rpms grows 25,52 %
- the size of the vibration acceleration amplitude with material removal of 2 mm in the comparison range reaches the highest value $3,78 \cdot 10^{-5}$ g at frequency 3,5 kHz and 800 rpms
- with the growing numerical value of the motor's rotations and material removal of 2 mm in the examined range the value of the vibrations acceleration amplitude grows and when compared to the 800 rpms and 120 rpms grows 61,90 %

6 CONCLUSIONS

The above results show that with the increasing speed of the rotation, the values of the mechanical vibrations gradually grow. With increasing thickness of the removed material the values of the vibrations acceleration amplitude have decreased. From the perspective of optimizing the process of turning on a lathe TOS SV 18RB it can be stated that it is necessary to avoid rotations of 800 and 1200 rpms when processing without load with respect to the values of the mechanical vibrations. The results achieved indicate continuation of the research, since this work is focused on examining the magnitude of the vibrations on the bearing house of the lathe TOS SV 18RB. Stated

results form part of experiments comparing the input parameters and their suitability for use in turning conditions.

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