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EXPERIMENTAL STUDIES RESULTS OF INFLUENCE OF WOOD-MILLING SHANK CUTTERS CONSTRUCTIONS ON NOISE LEVEL

In the article results over of experimental research of levels of voice pressure (air noise) are brought in a process to treatment of wood of different breeds, and also arboreal materials by the end milling cutters of two different constructions: with continuous and irregular canals taking of shaving from the area of cutting. Experiments realized at the facility, established on the basis of the machining center CNC ROVER B 4.35 (BIESSE, Italy). Continuous drainage channel chip is exposed to high sound pressure levels, both at idle and during cutting. The largest air noise occurs during the cutting of oak (95.3 dBA), and the smallest – MDF (80.9 dBA).

Introduction. At woodworking enterprises one of the topic problems is a reduction of levels of sound pressure (air noise), main source of which is wood-cutting tool during its exploitation.

One of the most wide-spread types of wood-cutting tool is shank cutters [1]. Shank wood-milling cutters operate at enhanced rotation frequencies (10,000–24,000 min^{-1}), have extended working part and, therefore, are often a source of high levels of sound pressure [2].

Constructions of modern shank cutters are various. Basing on the analysis of literature and information sources, it is found, that for processing of wood materials monolithic (one-piece) and assembly shank cutters are commonly used [3].

In Table 1 shank cutters of the most common constructions are performed.

Possessing different external appearance and structure of cutter elements, shank cutters become sources of air noise with different acoustic parameters during exploitation at different modes.

Additionally, during application shank cutters are positioned relatively to work piece with different length of console part, experiencing various elastic deformations, possibly influencing on the value of sound pressure level formed.

Studies of sound pressure levels are carried out at exploitation of wood-milling shank cutters of two constructions: with continuous and non-continuous spaces between cutters.

In Fig. 1 layout of the first test shank cutter (continuous spaces between cutters) is performed. In Fig. 2 layout of the second test shank cutter (non-continuous spaces between cutters) is performed. Diameters of cutting circles, angle characteristics of shank cutters for the two constructions were not different.

The purpose of the work is to determine experimentally influence of shank wood-milling tool construction peculiarities on the level of sound pressure (air noise), when processing wood and wood materials within wide range of parameters of cutting mode.

Main part. Experiments were carried out at the setup created on the basis of machining center with CNC ROVER B 4.35 (BIESSE, Italy). Measuring portable complex K5101 (National Instruments, USA), supplied with microphone 4942-A-021 of IEPE type, was used.

Measurements of mean square value of sound pressure in logarithmic scale at A-weighing filter within frequency range 8–16,000 Hz at microphone sensitivity 48.3 mV/Pa were carried out [4].

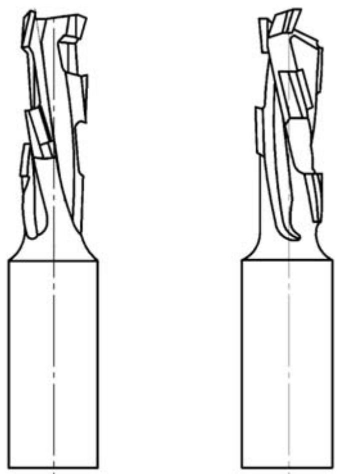


Fig. 1. Shank cutter with continuous spaces between cutters (milling tool 1)

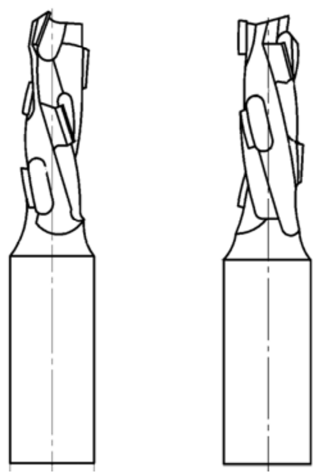
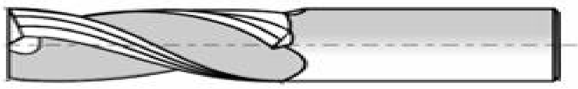
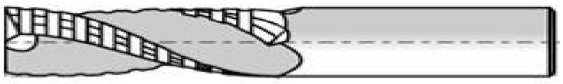
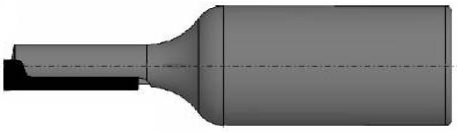
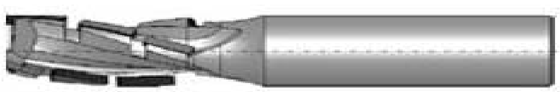


Fig. 2. Shank cutter with non-continuous spaces between cutters (milling tool 2)

Table 1

Common constructions of shank cutters for processing of wood materials

Type	Appearance of shank cutter	Description of construction
Monolithic of hard alloy		Monolithic with spiral shear made of hard alloy
		Monolithic with spiral separated shear made of hard alloy
Assembly with cutters made of hard alloy		Assembly with non-detachable fastening of hard alloy cutter by brazing
		Assembly with spiral separated shear made of hard alloy, form by non-detachable fastening of hard alloy cutters by brazing
		Assembly with mechanical fastening of hard alloy cutters

Preliminary, influence of shank cutter position against work piece (maximal milling tool overhang against work piece (+1), minimal possible milling tool overhang (–1), average position (0)) on the level of sound pressure was investigated. In the experiment shank cutter with continuous spaces between cutters (milling tool 1), possessing lower cross-section of the body and by several times more experienced to elastic bends when subjected to cutting force constituents, was used.

Mode and results, at which the experiment was performed, are given in Table 2.

Table 2

Shank cutter exploitation modes in the experiment on influence of milling toolposition against work piece

Material processed	Milling tool position	Rotation frequency of milling tool, n, min^{-1}	Supply rate, m/min	Sound pressure level (milling tool 1), dBA	
				no-load	cutting
Chipboard	1	12,000	6.6	77.6	85.2
	1	16,000	8.8	78.5	86.1
	1	20,000	11.0	83.9	90.3
	0	12,000	6.6	77.8	85.4
	0	16,000	8.8	78.3	86.3
	0	20,000	11.0	83.6	90.8
	–1	12,000	6.6	77.5	85.8
	–1	16,000	8.8	78.9	86.5
	–1	20,000	11.0	83.4	89.9

Analysis of the experimental result showed, that position of shank cutter against work piece has no essential effect on sound pressure level when cutting.

Therefore, investigation of shank cutter rotation frequency influence on sound pressure level was further performed at medial position of the tool against the material processed.

Modes and results, at which the experiment was performed, are given in Table 3.

Table 3

Influence of shank cutters rotation frequency of two constructions on sound pressure level

Material processed	Rotation frequentcy, n, min^{-1}	Supply rate, m/min	Sound pressure level, dBA			
			milling tool 1		milling tool 2	
			no-load	cut	no-load	cut
MDF	12,000	6.6	78.4	85.9	74.7	84.4
	16,000	8.8	78.5	84.7	76.7	80.9
	20,000	11.0	82.4	88.9	82.4	87.0
Chipboard	12,000	6.6	78.8	85.4	73.2	82.8
	16,000	8.8	78.4	86.3	74.2	83.5
	20,000	11.0	82.9	91.2	76.1	87.7
Beech	12,000	6.6	77.1	92	74	88.6
	16,000	8.8	78.3	93.2	75.4	89.5
	20,000	11.0	85.1	95.7	82.1	92.3
Oak	12,000	6.6	77.3	93.2	74.2	91.9
	16,000	8.8	78.3	91.5	73.8	90.5
	20,000	11.0	86.4	96.6	82.2	95.3
Birch	12,000	6.6	76.7	89.1	74.4	88.4
	16,000	8.8	77.9	89.7	73.8	89.2
	20,000	11.0	81	92.3	80.1	91.2
Average	12,000		**77.7**		**74.1**	
	16,000		**78.3**		**74.8**	
	20,000		**83.6**		**80.6**	

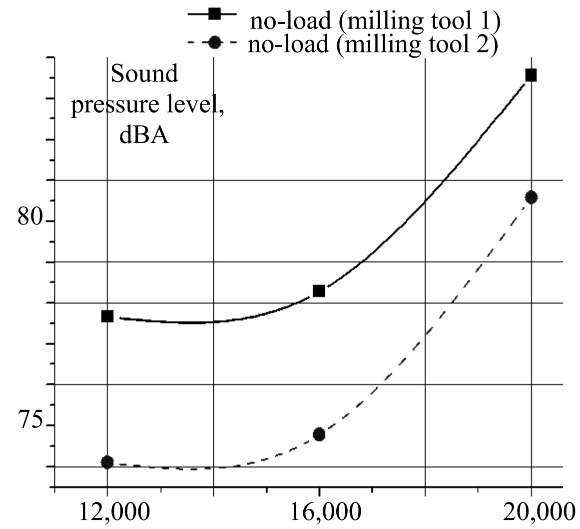


Fig. 3. Plots of sound pressure levels dependences on milling tools rotation frequencies (without cutting)

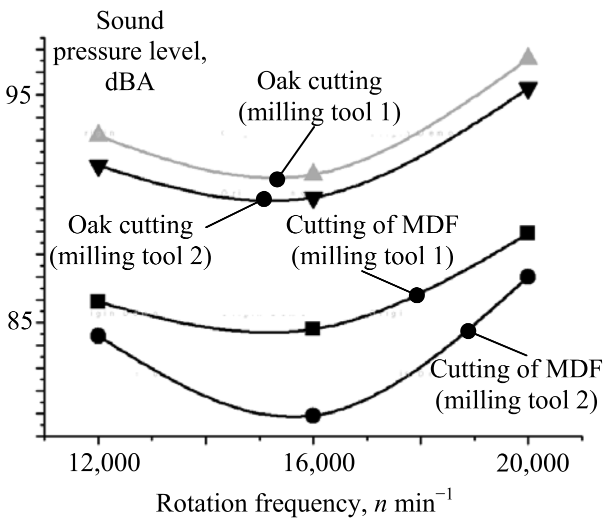


Fig. 4. Plots of sound pressure levels dependences on milling tools rotation frequencies when cutting

By the results of experimental studies characteristic curves were built for shank cutters sound pressure levels depending on their rotation frequencies at no-load and during cutting when processing oak wood, as well as wood material – MDF (Fig. 3, 4).

Conclusion. Continuous channel for chip removal is a source of enhanced sound pressure level both at no-load, and when cutting.

Maximal air noise occurs when cutting oak wood (95.3 dBA), while minimal does at processing of MDF (80.9 dBA).

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