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Impact of the cutting edge condition on the results of oak wood milling

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Abstract: *Impact of the cutting edge condition on the results of oak wood milling.* The study presents results of investigations dealing with the effect of wear of cutting edges for profile milling on oak wood (*Quercus robur* L.) surface roughness. The discussed experiments were carried out on a Weeke-Venture 3 processing centre using a profile cutterhead with a blade fixture of the ProfilCut type of Leitz Company. Investigations included analyses of the surface obtained as a result of processing after the execution of the milling distance corresponding to: 1, 50, 100, 200, 300 and 400 running meters (rm). Values of the following two main surface roughness parameters were determined: arithmetic average height Ra and the average peak to valley roughness Rz. A significant increase of the analysed roughness parameters in the function of machining distance was found.

Key words: cutting edge wear, surface geometric structure, wood milling, oak.

INTRODUCTION

Oakwood is widely applied in various sectors of wood industry. Due to its hardness and durability, it provides good material for the manufacture of solid furniture of both functional and representative value. Oakwood is also frequently used to manufacture small ornamental elements of complex shapes. Wood structure, on the one hand, constitutes material resistant to surface damage and, on the other, poses a number of problems connected with its processing. The requirements are associated with the selection of appropriate tools of specific geometry and cutting edge structure which will ensure proper durability and processing quality.

Wood profile milling is usually realised using cutterheads with various methods of chucking of cutting edges on numerically controlled woodworking machines. The way of cutterhead fixing in working assemblies of CNC woodworking machines plays a significant role and the quality of the finished surface is very important. The quality of the processed surface is usually assessed on the basis of such roughness parameters as Ra and Rz (Aguilera & Zamora 2009, Pinkowski et al. 2009, Pohl 2005).

Variability of the applied timber materials as well as their impact on treatment processes make is necessary to conduct many investigations concerning the processing effects of solid wood and wood-based materials examining various aspects of the process, e.g. in the function of rotation velocity of the tool wear (Mitchell & Lemaster 2002, Szymański et al. 2009). The aim of these experiments was to ascertain the impact of the tool condition undergoing wear during oakwood milling on the quality of the surface obtained following profile milling.

METHODS

An oakwood multisample was prepared. Consecutive profile millings approximately 100 mm long one after another were carried out along side planes of the multisample. Consecutive millings were performed using a tool after a specific production cycle of oakwood profile processing. The processing cycle was determined by the realised distance of machining by the given blade expressed in running meters. The multisample was milled along the following distances: 1, 50, 100, 200, 300 and 400 running meters (rm) which allowed standardisation of the experimental conditions with regard to their comparability.

The following processing parameters were employed during investigations:

- feed speed $v_f = 3\ m{\cdot}min^{-1}$
- maximum machining diameter $D_{max} = 85mm$
- minimum machining diameter $D_{min} = 52mm$
- rotational speed $n = 12000min^{-1}$
- number of machining cutting edges $z = 2$.

A Leitz Company profile, mandrel double-blade cutterhead with PrifilCut type of blade fixing was used and the processing was conducted on a Weeke-Venture 3 processing centre. The cutterhead was fixed in a chuck of the machine working assembly using an HSK cone. The milling elements and the multisample during processing were fixed using chucks which allowed processing of narrow elements. The tool as well as the numerical centre used in experiments is presented in Figure 1.

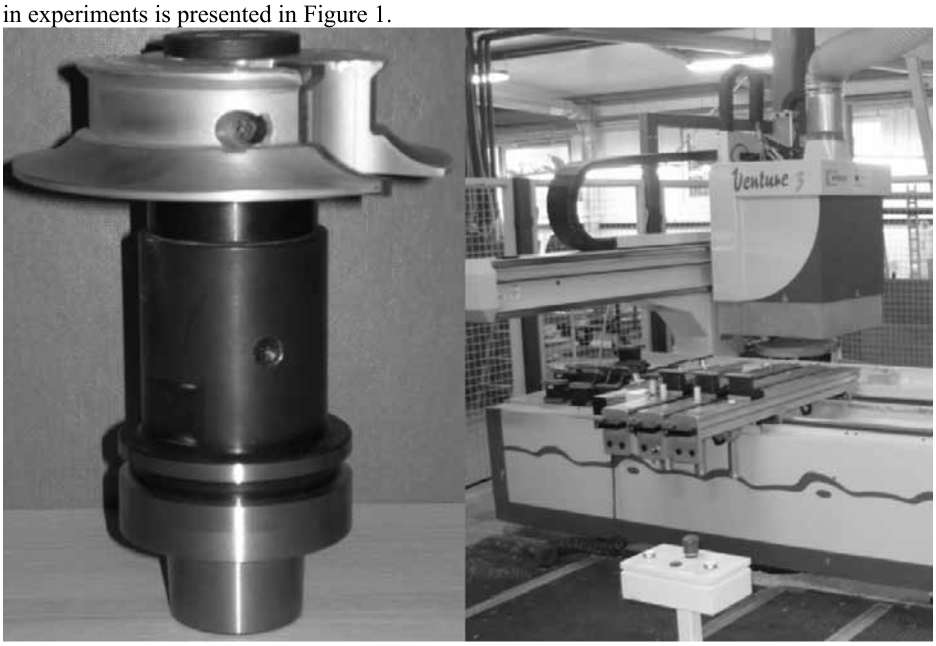

Fig. 1. Cutterhead and CNC woodworking machine employed in experiments

The performed analyses involved the multisample processed using a tool with new blades and with the same but worn blades along the following machining (oakwood profile milling) distances: 1, 50, 100, 200, 300 and 400 rm.

Moisture content of the experimental sample was 8%. Selected surface roughness parameters for two measurement places of each segment of the milled profile were examined: one surface was situated paralelly to the tool rotation axis (B) and the other – perpendicularly to the tool rotation axis (A). Designations of places of measurements are shown in Figure 2.

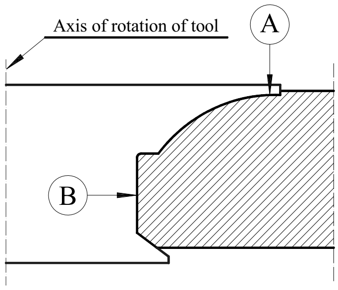

Fig. 2. Designations of places of measurements

Surface profiles were recorded using a Carl Zeiss ME-10 profilomerter equipped in a measuring gauge with a rounding radius of 10 μm and the apex angle of 90^o. The feed velocity in the course of recording of the profile was set at 100 $μm·s^{-1}$. Data collected during recording were subjected to filtration in accordance with PN-EN ISO 13565-1:1999 and PN-EN ISO 11562:1998 standards. The applied cut-off length was 0.8 mm. The following parameters of wood surface roughness were adopted in accordance with the PN-84/D01005 standard: arithmetic average height Ra and the average peak to valley roughness Rz.

RESULTS

Calculated values of roughness parameters are shown in Table 1. Figures 3 and 4 present comparisons of surface roughness parameters of the examined samples depending on the milling distance.

Table 1. List values of the analysed surface roughness parameters

Milling distance [m]	Parameter Ra [μm]		Parameter Rz [μm]	
	measurement place		measurement place	
	A	B	A	B
1	0,93	0,76	5,24	4,32
50	1,29	0,98	5,7	5,67
100	1,12	1,12	7,09	7,01
200	1,66	1,54	10,04	8,04
300	1,84	1,7	8,47	9,08
400	1,59	1,59	8,28	8,34

The dependence of the arithmetic average height of the Ra profile on the machining distance showed an increasing tendency. This trend was noticeable for both measurement places and ranged from 0.76 μm – for the initial value of the machining distance for place B to 1.84 μm for the machining distance of 300 rm, for place A. Slightly higher values of the Ra parameter for the A measurement place than for place B can be noticed in Figure 3.

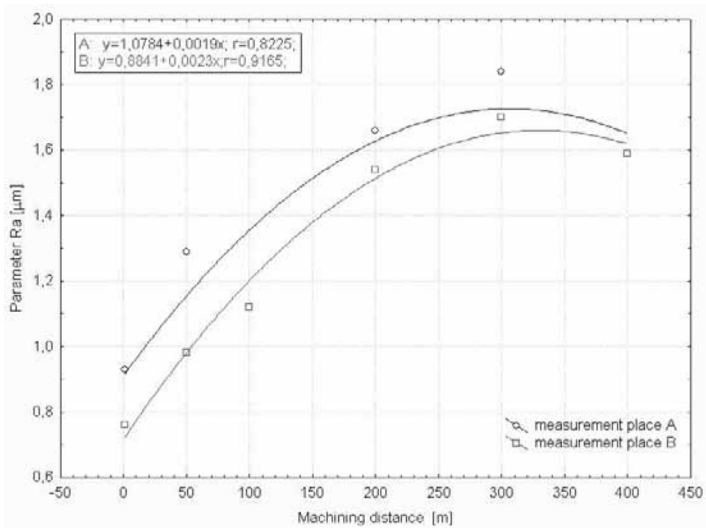

Fig. 3. Arithmetic average height Ra of the profile depending on the machining distance for the analyzed measurement places

A similar tendency was observed in the case of the unevenness height of profile Rz. Also here, a distinct growing trend is visible. The smallest values of this parameter (Fig. 4) were found for the surface obtained after the machining distance of 1 rm, while the highest values for the surface obtained after the machining distance of 300 rm. Analysing the obtained research results, it can be stated that the surface obtained after the machining distance of 400 rm was characterised by smaller values of both parameters.

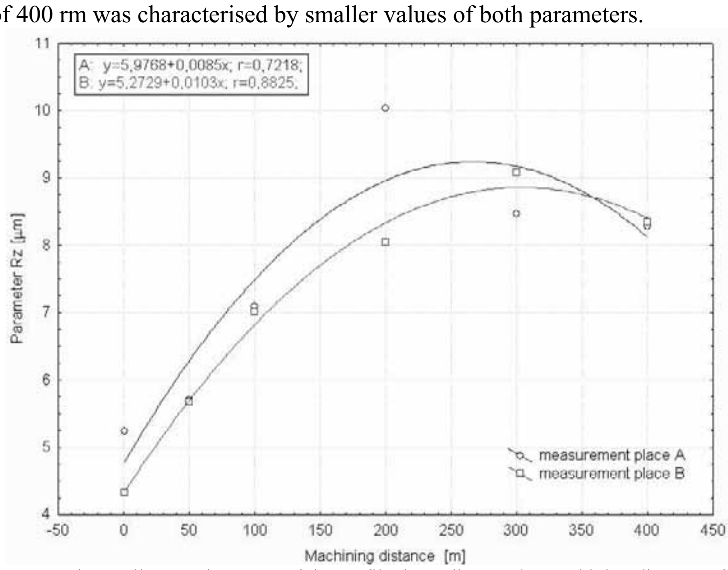

Fig. 4. Average peak to valley roughness Rz of the profile depending on the machining distance of the tool for the analysed measurement places.

In the final phase of the analysed machining distance, i.e. 400 rm, burns were found to occur which probably contributed to surface smoothing which may explain the lower values of both analysed roughness parameters.

CONCLUSION

The results of the performed investigations showed that, together with the increase of the machining distance, values of roughness parameters Ra and Rz were also found to increase. However, both values declined in the case of the longest analysed machining distance. The most probable cause of this situation could have been the phenomena which contributed to burning of the examined surfaces.

Slight difference occurred in the obtained values of the surface roughness parameters for the two measurement places determined on surfaces perpendicular to each other. Higher values of roughness parameters were recorded for the surface oriented perpendicularly to the rotation axis which could be attributed to the unfavourable configuration of this surface from the point of view of the construction of the tool cutting edge.

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Streszczenie: *Wpływ stanu ostrza na efekty frezowania drewna dębowego.* W pracy zaprezentowano wyniki badań wpływu zużycia ostrzy noży do frezowania profilowego na chropowatość powierzchni drewna dębowego (Quercus robur L.). Badania wykonano na centrum obróbkowym Weeke-Venture 3 z zastosowaniem głowicy frezowej profilowej z mocowaniem noży typu ProfilCut firmy Leitz. Analizowano powierzchnię uzyskaną w wyniku obróbki po zrealizowanej drodze skrawania równej 1, 50, 100, 200, 300 i 400mb. Wyznaczono wartości dwóch podstawowych parametrów chropowatości powierzchni tj. średniego arytmetycznego odchylenia profilu Ra oraz wysokości nierówności profilu Rz. Stwierdzono istotny wzrost analizowanych parametrów chropowatości w funkcji drogi skrawania.

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