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OVERALL SET OF BANDSAW TEETH VERSUS METHODS OF MEASUREMENTS

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Abstract

This article deals with the impact of the manual methods of measurement on the overall set measurement results. It describes the results of the measurement of bandsaw teeth kerf with the use of a micrometer and a digital calliper.

It is commonly known that the cutting process causes the wear of cutting tools. The wear of the cutting edge depends on the cutting conditions as well as on the mechanical properties of the processed material.

One of the methods used to estimate the state of saw teeth uses kerf measurements. The overall set of teeth of the bandsaw Prime ST 0.8/1.2 by Wintersteiger, which was used in the oak wood re-saving process, was measured using a micrometer and a digital calliper. The results of different measurements were compared to estimate the accuracy and precision of those methods. It was shown that micrometer measurements were much more precise than calliper measurements. It was also noted that the kerf varied between two tooth ranges.

Key words: *Bandsaw, Overall set (kerf), tool wear, digital calliper, micrometer*

INTRODUCTION

The saw's teeth become blunt during use. A lot of research has focused on the cutting edge wear problem. They showed that the wear of the cutting edge depends on the cutting conditions as well as on the mechanical properties of the processed material. For wood, there are more factors than for metals, e.g. defects (knots), annual rings, moisture content, etc. (Csanady and Magoss, 2020; Klamecki,1979).

The impact of saw blade override on cutting-edge radius and recession was demonstrated by Šustek and Siklienka (2012). A decrease in the override from 5 to 50 mm resulted in a decrease in edge recession and cutting edge radius.

The dependence of tool wear on surface quality was studied by Kminiak et al. (2015, 2016). The articles have not proven any direct relationship between tool wear and surface quality.

Orlowski et al. (2021) used a NIKON ECLIPSE Ti-S microscope equipped with a NIKON DS-Fi2 recording camera to take pictures of teeth, which were then analysed in a graphical software to measure the radii of the main cutting edges. Currently, to estimate the state of a bandsaw teeth most often micrometer are used in measurements.

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An innovative way to determine the wear of a cutting tool was proposed by Brili et al. (2021). In the model, a cutting tool was monitored with an infrared (IR) camera immediately after the cut and for the following 60 s. Thanks to deep learning algorithms, this model allowed over 96% accuracy of assessment.

The goal of this papier was the comparison of measurements accuracy of bandsaw teeth with a digital calliper and a micrometer. The latter methods seem to be appropriate for industrial condition and simultaneously be much simpler to realize in industrial conditions in comparison to complicated instrumentation such as a microscope.

MATERIALS AND METHODS

The object of the measurements was Prime ST 0.8/1.2 by Wintersteiger (Innkreis, Austria). The examined saw was used in the re-sawing process of oak (*Quercus* L.) "wet" boards (average MC = 32,9% with standard deviation SD_{MC} = 2,1%) and was waiting for the regeneration process (re-griding). The saw blade's technical specifications were as follows: saw thickness s = 0.8 mm, overall set (kerf) S_t = 1.2 mm, tooth pitch P = 25 mm, number of teeth n = 220, rake angle γ_f = 20°, blade angle β_f = 60°, tooth type - stellite tipped.

Four measurement series of the overall set were made, two using a digital calliper (type Gedore No. 711, 0–150 mm, UK), and two with the use of a micrometer. Then, the results of those measurements were analysed and compared.

RESULTS AND DISCUSSION

The results of the measurements were analysed. The digital calliper measurement series were named C1 and C2, whereas the micrometer measurement series were named M1 and M2. Arithmetic means series of calliper and micrometer measurements were named C and M. The arithmetic mean and standard deviation of every series were determined and compared (Table 1). The values of the mean series (C and M) are shown in Figure 1.

Table 1. Differences between arithmetic mean and standard deviation of measurement series

Series Code	Standard Deviation	Arithmetic Mean	Percentage Standard Deviation
	[μm]	[mm]	[%]
M1	9.40	1.209	0.78
M2	9.51	1.209	0.79
M	9.45	1.209	0.78
C1	13.53	1.184	1.14
C2	10.11	1.195	0.85
C	13.13	1.189	1.10

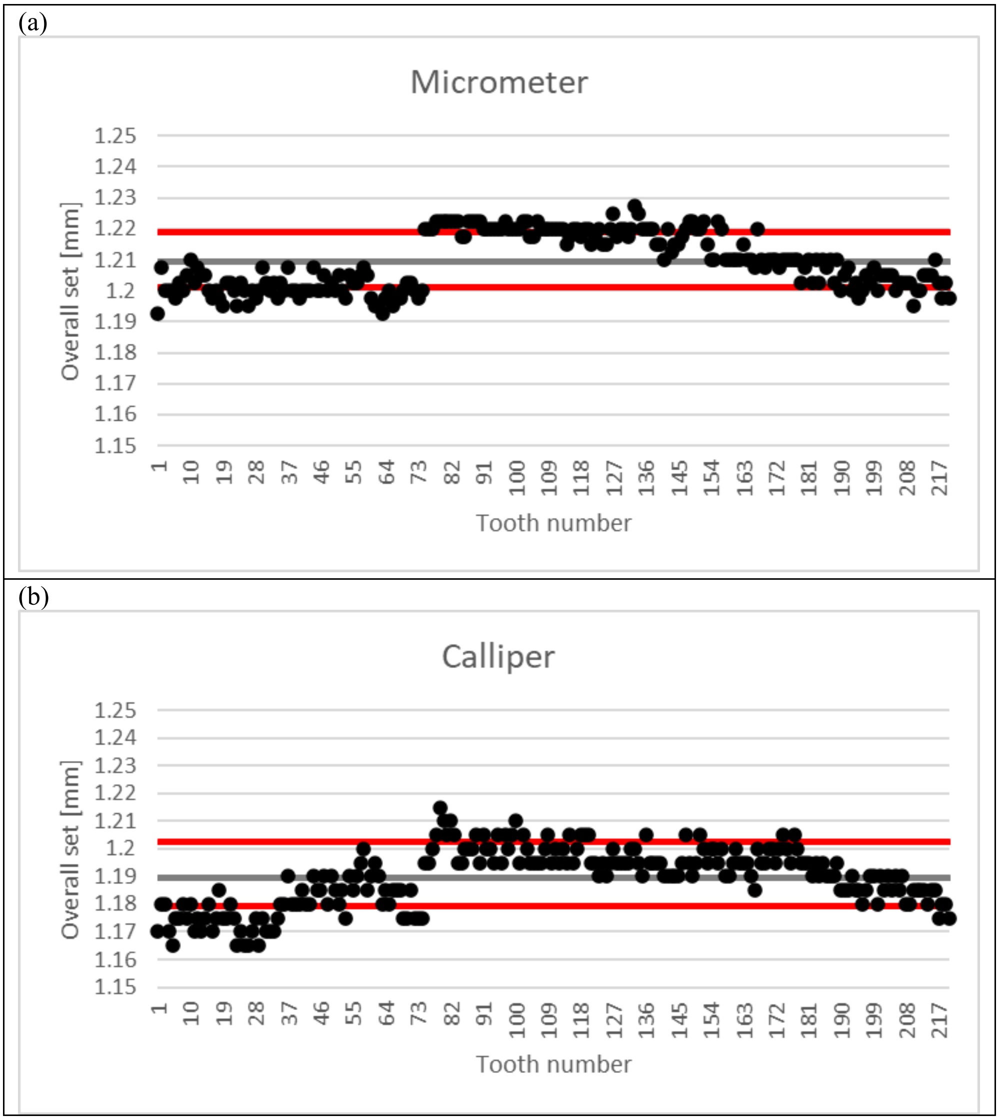

Figure 1. The overall set of bandsaw teeth, measured with: a micrometer (series M) (a); a digital calliper (series C) (b)

The measurement series were statistically compared. The differences between values from series M2-M1, C2-C1, C-M were shown in Figure 2. The standard deviation, arithmetic mean of differences between those series were calculated. Also, the differences between arithmetic means of those series were determined. Those values were shown in Table 2.

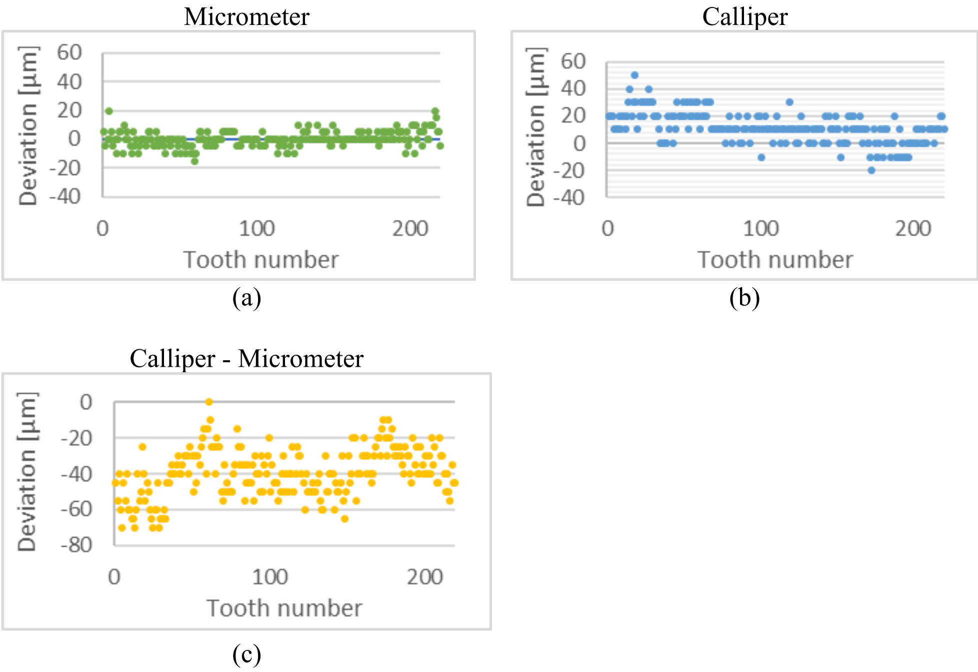

Figure 2. Tooth kerf measurements deviation between: M2 and M1 series (a); C2 and C1 series (b); C and M series (c)

Table 2. Statistical parameters of differences between measurement series

Series Code	Standard Deviation [µm]	Mean Deviation [µm]	Difference of Arithmetic Means [µm]
M2 to M1	5.4	3.6	0.1
C to M	13.4	10.6	-39.6
C2 to C1	11.0	8.2	10.9

CONCLUSIONS

The comparison of saw overall set measurement methods has allowed for following conclusions:

- The arithmetic mean of micrometre measurements (M_M=1,209 mm) is higher than the arithmetical mean of calliper measurements (M_C=1,189 mm) and exceeds the assumed value. This size is even greater than the standard kerf of the new bandsaw, which leads to the conclusion that probably the micrometer could not be correctly calibrated.
- The percentage standard deviation of micrometre measurements ($SD_{M\%}$ = 0,78%) are smaller than the percentage standard deviation of calliper measurements ($SD_{C\%}$ = 1,10%). Also the standard deviation between M2 and M1 series ($SD_{M2\text{-}M1}$ = 5,4 µm)

is lower than between C2 and C1 (SD_{C2-C1} =11 μm). That means, the micrometer measurements are more precise.
- Both type of measurements have shown the difference of tool wear between two teeth intervals.

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