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EFFECT OF SAW BLADE OVERLAP SETTING ON THE CUTTING WEDGE WEAR

Ján Šustek − Mikuláš Siklienka

ABSTRACT

In the presented paper there are the results of experimental measurement of tool-wear in the cutting process with circular saw of beech wood in dependence on the overlap 5 and 50 [mm]. The article used different methods of assessing the wear of the cutting tool. The circular saw blade from HSS, made by Pilana was used for the experiment. The measurement was carried out by the circular saw DMMA–36. When comparing the 5 mm and 50 mm overlap, it was found that at the overlap p = 5 mm it was cut approximately 1500 meters less of the linear distance of wood than at p = 50 mm overlap, while the tool-wear was roughly the same.

Key words: circular saw, tool-wear, overlap, clearance, circular saw blade.

INTRODUCTION

The wear can be defined as a gradual change of micro-geometry of wedge in the course of cutting, when the tool is loosing its ability of cutting. It is caused by the fact that particles of metal are separating from the wedge. A tool is worn when the wedge has come into a critical state, which is accompanied by an intolerable degradation in quality of the work-piece surface, undesirable increasing of cutting power, burning, and dimensional inaccuracy of the work-piece (untrue running of saw blades) (PROKEŠ 1980).

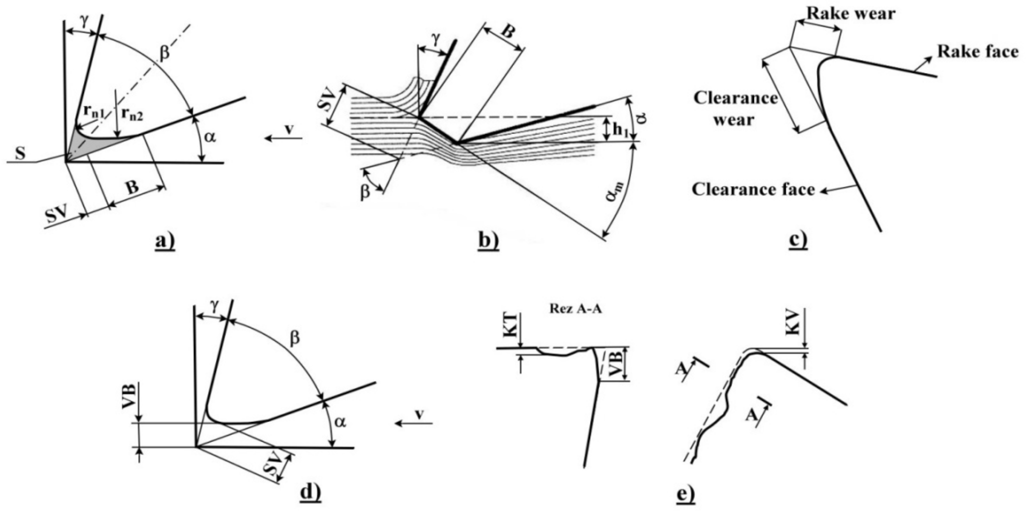
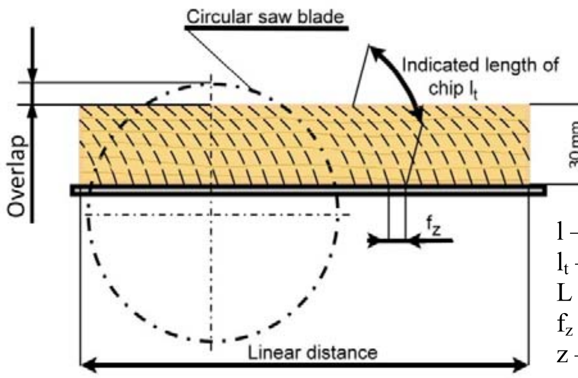


Fig. 1 Methods of measurement of the cutting wedge tool-wear.
a) ON 490201 SLOVAK STANDARD – 1987 b) GOTTLOEBER, FISCHER, FISCHER 2001; c) DARMAWAN, TANAKA, USUKI, OHTANI 1999; d) SALJĚ, DRÜCKHAMMER, STÜHMEIER 1985; e) BEKÉŠ, HRUBEC, KICKO, LIPA 1999.

From the survey of the direct methods of measurement of the cutting wedge tool-wear (Fig. 1) we can state, that individual authors (1a–e)) have tried to do their best in recording the rate of the cutting wedge tool-wear, and they make use of various characteristics for its determination. The same characteristics are measured by individual authors in different directions and the acquired values are not mutually comparable. One characteristic does not always express the total rate of the cutting wedge tool wear, and it is necessary to measure more of characteristics, or give the graphic description of the cutting wedge point prior and after the tool wear. A great disadvantage of individual characteristics of the tool wear are their very small values, unclear transitions from round to straight form, etc. As follows from the survey, there are no unified methods of the tool wear cutting wedge measurement at wood working, which is a problem from the viewpoint of comparison of experimental results. In the process of sawing wood beside the main products of the chip - sawdust, whose shape, size and quantity is dependent on the physico-mechanical properties of sawing wood, as well as the shape, size, sharpness of the cutting tool and the technical-technological conditions of implementation of sawing (GOGLIA 1994, LISIČAN *a kol.* 1996, OČKAJOVÁ *a kol.* 1996, SIKLIENKA 2004, KLEMET – DETVAJ 2007, KOPECKÝ – ROUSEK 2007, DZURENDA 2009).

The aim of this paper is an inquiry into the change of a cutting wedge profile in dependence upon the saw blade overlap over the cut. The relational quantity is a very substantial factor regarding the degree of tool wears. The rate of tool wears can be evaluated regarding to the cut area, linear distance of cutting or regarding to the indicated length of chip per tooth l – the trajectory of saw tooth in the test sample (Figure 3). You can see a difference between an indicated length of chip per tooth l and the linear distance L in Figure 4. The chose method of cutting wedge tool–wear measurement is written in the chapter Materials and Methods. The information concerning these problems can be found only in limited amount.



$$l = \frac{L}{f_z} \cdot \frac{l_t}{z} \qquad [m]$$

l – indicated length of chip per tooth
l_t – indicated length of chip
L – linear distance
f_z – feed per tooth
z – number of teeth

Fig. 2 Difference between linear distance and indicated length of chip.

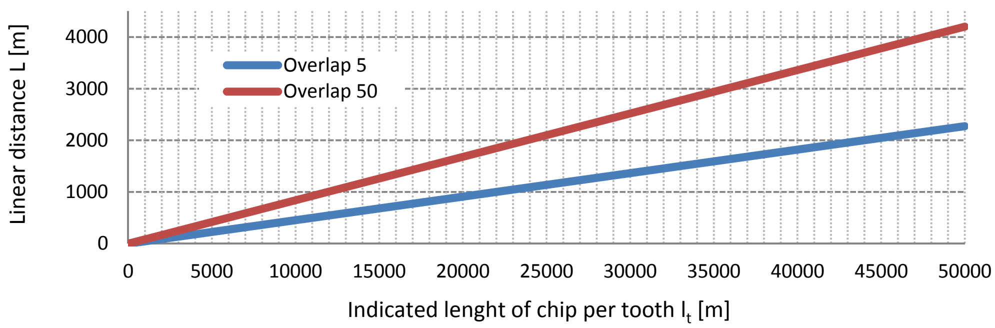


Fig. 3 Difference between linear distance and indicated length of chip per tooth.

MATERIALS AND METHODS

The measurement was carried out on the experimental test stand designed at the Department of Woodworking (SIKLIENKA *et al.* 1999). It is a joiner circular saw.

<u>Technical parameters of the joiner circular saw:</u>

Type:	lateral – longitudinal circular saw (joiner)
Main motor power:	5,5 [kW],
Rotational speed of spindle:	2900 [rpm]

The cutting process was carried out with a circular saw blade made of high-speed steel. The saw blade had the following parameters:

<u>Parameters of the circular saw blade HSS</u>

Diameter:	400 mm
Saw blade thickness:	2,5 mm
Number of teeth:	32
Width of cut:	3,6 mm
Permissible rotational speed:	3800 [rpm]
Producer:	Pilana (CZ)
Angle front	$\alpha = 15°$, wedge angle $\beta = 50°$, rake angle $\gamma = 25°$

Experimental tests were carried out on the beech test samples (*Fagus silvatica*). The samples were handled so as to contain the least possible number of knots, resin canals, and had approximately the same structure of wood (annual rings). The wood was sawn tangentially. The sawn wood was dried and seasoned to 12 ± 1 % of moisture content. After drying, the species with dimensions 30 mm × 150 − 250 mm × 1000 mm were handled out.

In cutting process the following overlaps of the saw blade were used p = 5 a 50 mm and feed speed $v_f = 10\ m \cdot min^{-1}$. Individual species were cut longitudinally on a circular saw at the given changed cutting conditions. The rate of tool-wear was monitored in dependence on the indicated length of chip per tooth (length of tooth path in the test samples). Recording of the tooth profile was carried out by the laboratory equipment shown in Figure 2.

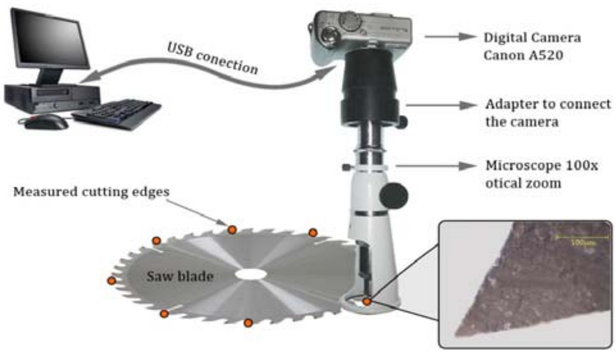


Fig. 4 Laboratory equipment for scanning of the cutting wedge tool-wear.

Saw blade was divided into 4 zones, and two cutting wedges were chosen in the each zone. Cutting wedges were chosen according to the initial condition of the tool-wear (identical). The snapshots of the cutting wedge profile were recorded in the following working points of the indicated length of chip per tooth l graded in 2000 m up to 50 000 m during both of the overlap. The tool-wear was evaluated by means of the two parameters i.e. by the radius of the cutting edge r_n and by recession of the cutting edge SV. These characteristics are shown in the Figure 5.

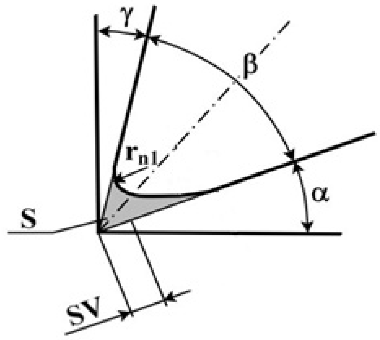


Fig. 5 Methods of measurement of the cutting wedge tool-wear.

As it has been already mentioned, the snapshots were performed by means of laboratory equipment and subsequently elaborated in the Impor 5 professional software. In this software there were also made interleaving of individual snapshots of cutting wedge during cutting test.

In Fig. 6 and Fig. 7 there are recorded the real contours of the cutting wedge at determined measuring points. The gradual change of the cutting wedge during sawing at the used overlap 5 mm over the cut is shown in Fig. 6 and in Fig. 7 is used the overlap 50 mm.

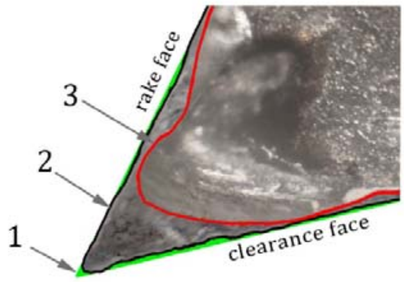


Fig. 6 Tool wear of the cutting wedge at the overlap p = 5 mm, 1) theoretical (proposed) state, 2) start state, 3) final state after l_t =50 000 m.

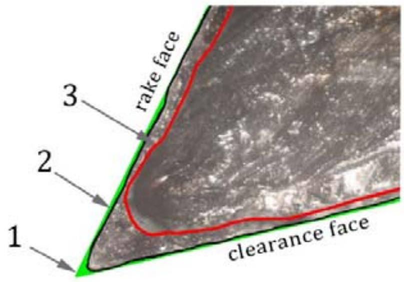


Fig. 7 Tool wear of the cutting wedge at the overlap p = 50 mm, 1) theoretical (proposed) state, 2) start state, 3) final state after l_t =50 000 m.

RESULTS AND DISCUSSION

The main task of this paper was to show an effect of technological parameter mainly the overlap of the saw blade over the work-piece on the tool wear of the cutting wedge.At present there are many authors expressing the tool wear in dependence on the sawn running metres or on the quantity of the cut area. However, these indices do not belong to the most accurate criteria for evaluation of the tool wear. It is due to fact that at different technological parameters of cutting, the cutting conditions are changing (indicated length of chip, feed per tooth …), which causes that our results cannot be mutually compared. Therefore we want to point out the significance of overlap on the tool wear of the cutting wedges.

From the Figure 6 and 7 we can state that the tool wear (recess) of the cutting wedge is nearly the same at both the used overlaps in cutting indicated length of chip per tooth 50 000 m. At higher overlap there was manifested the greater tool wear of round cutting edge than at the overlap p = 5 mm. It is necessary to emphasize that with changing overlap it comes to the change of indicated length of chip. With increasing overlap, the contact angle decreases, and so also does the indicated length of chip. In Fig. 8 are represented the dependencies of tool wear on indicated length of chip per tooth.

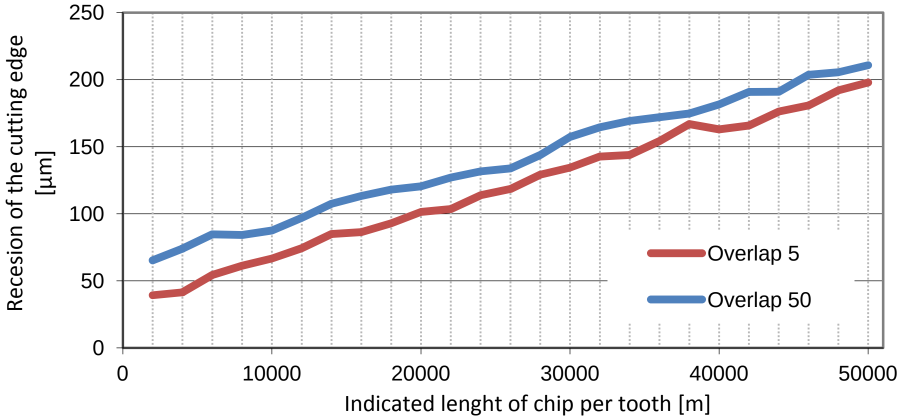


Fig. 8 The affect of overlap (clearance) of the cutting edge on the indicated length of chip per tooth.

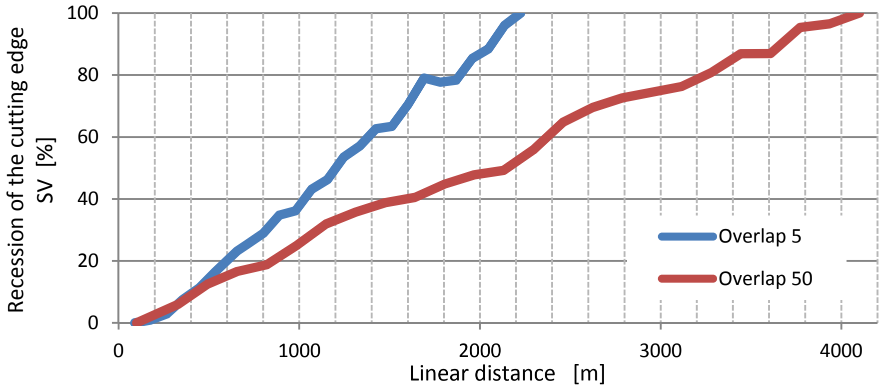


Fig. 9 The affect of recession of the cutting edge on the linear distance.

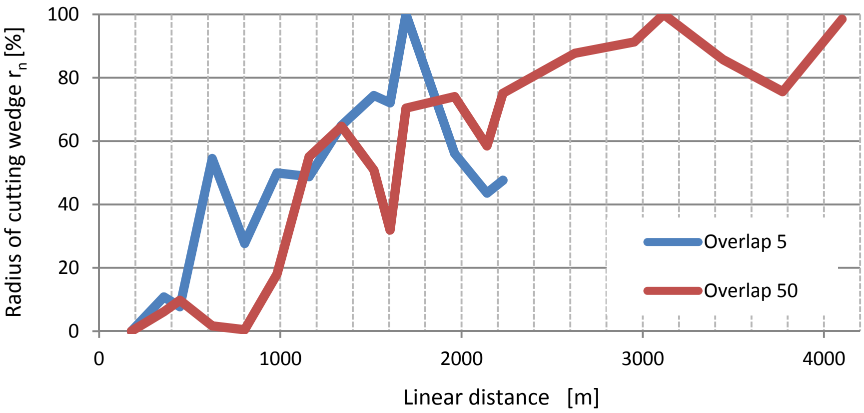


Fig. 10 The affect of radius of the cutting edge on the linear distance.

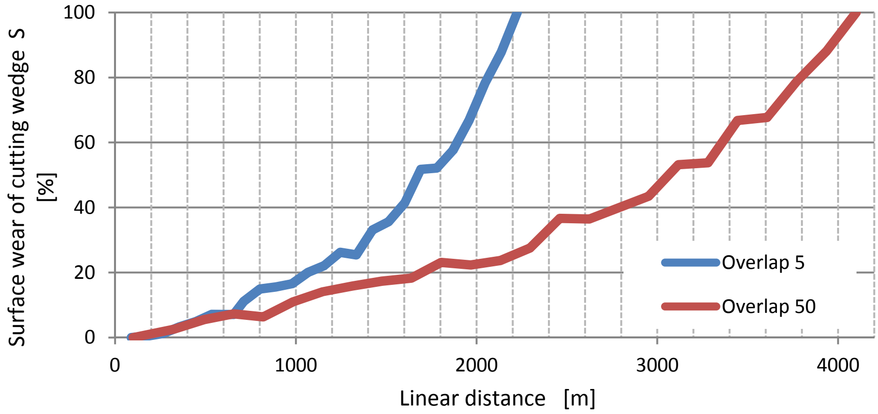


Fig. 11 The affect of surface wear of the cutting edge on linear distance.

With the change of the overlap from 5 mm to 50 mm and with the thickness of the test specimen h = 30 mm we need almost double amount of sawn wood to attain the same indicated length of chip per tooth. It means that at a higher overlap, the tool wear is smaller in dependence on the cutting length Fig 9. According to several authors, there is less overlap in the blade will wear faster cutting wedge Fig. 9 (OČKAJOVÁ 1996). Because the measurement of the wear surface of cutting wedge in the past in terms of measuring and calculating the most difficult authors focused on the evaluation of wear parameters by waiving the cutting edge or radius of the cutting wedge (KOVÁČ *et al*. 2010). By now, we can use the digital images to evaluate worn surface. Therefore appears to us using the evaluation method of wear worn surface than the most complex Fig. 11.

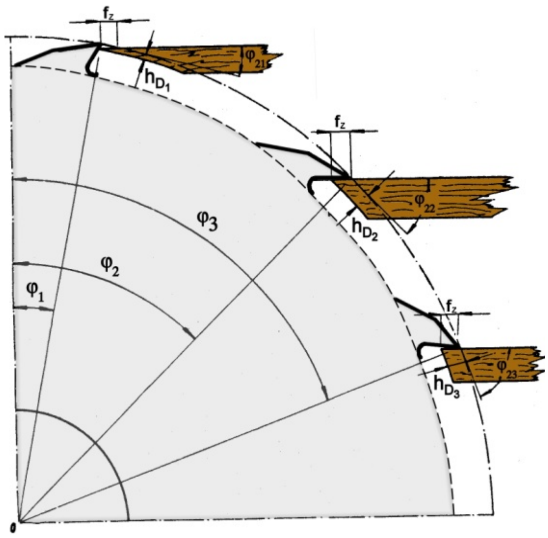


Fig. 12 Changing cutting conditions due to variations of the overlap.

CONCLUSIONS

An endeavour of this paper was to point out the importance of the saw blade overlap. The choice of appropriate overlap is quite substantial. With the change of overlap it comes to the change of parameters of the cutting process. But we cannot state unambiguously that the greater overlap, the better. The entering angle φ is the main factor influencing the fact that with increasing overlap comes to a smaller tool-wear. This angle determines how large the working rake angle, which is changing during the cutting, is. For better understanding in Figure 12 are shown three different positions of the cutting wedge in the cut material.

Although the durability of cutting edge is longer, the increased overlap has an affect on the other factors; with greater overlaps there are greater diameters of saw blades as well as there is a greater thickness of the saw blade, which subsequently causes an increase in the amount of sawdust. Apart from this, with an increase of overlap, the stability of saw blade decreases. All these factors must be taken into account and by means of a complex study of these factors find the optimum of saw blade overlap of the over the cut.

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Adresa autorov

Ing. Ján Šustek, PhD.
Prof. Ing. Mikuláš Siklienka, PhD.
Technická univerzita vo Zvolene
Drevárska fakulta
Katedra obrábania dreva
T. G. Masaryka 24
960 53 Zvolen
sustek@vsld.tuzvo.sk