

## EXPERIMENTAL STUDY IN PRIMARY WOOD CUTTING WITH CIRCULAR SAW AND BAND SAW MACHINE

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### ABSTRACT

Experimental research on some performance indicators of a circular saw machine (*Kallion Konepaja Oy – Finland*) for longitudinal cutting of logs were performed. The accuracy of the machine operation and the roughness of the boards were measured successively. For this purpose, the feed speed  $v_f$  was varied widely, from 4 to 100 m.min<sup>-1</sup>. The test specimens are of beech wood (*Fagus silvatica L.*). The research place was the manufacturing facility of *Pentop Ltd.* – Varshets. The results were analyzed and compared with those obtained previously with a band saw machine.

**Key words:** circular saw machine, logs, surface quality, productivity.

### INTRODUCTION

One of the main issues facing the producers in Bulgaria working in wood processing is “What is the best technology for the specific manufacture”? In this case we are talking about production related to the primary processing of round wood materials – logs sawing. During this processing of the materials in the woodworking factories boards, beams, prisms and other shaped materials are obtained. In our country band saws, circular saws and frame saw machines are used for this operation (Filipov 1979, Obreshkov 1995). In addition, in some countries in the Scandinavian Peninsula and North America, chainsaws are used, which are adapted for longitudinal cutting.

The most widely used in our country are band saw machines. This is mainly due to their main advantages – relatively easy maintenance, low energy consumption and the narrower cut obtained from their tools. In the last two decades, investments have been made mainly in modern horizontal band saws, also called mobile. These are machines that are easier to maintain than vertical ones,

which are significantly heavier and more energy consuming. Their main disadvantage is the low productivity, which is a result of the lower stability of the cutting tool at high feed speeds (Atanasov 2014).

Circular machines find limited application mainly due to the wider cut that is obtained when working with them. In Bulgaria, circular machines with two blades are mainly used. With them, through two passes of logs with small diameters, shaped materials with a square cross section are obtained. In practice, these machines are called "beamers".

Mainly due to a significant reduction in the volume of work, in recent years in our country gang saw machines are finding limited application. This makes their application inexpedient in practice, as their main advantage is productivity.

Chainsaws for longitudinal cutting do not differ significantly from those used in logging. Their main difference is in the angular parameters of their cutting edges.

There are definitions of surface quality in the literature that differ from each other. Most of the authors identify it with roughness, but there are those who associate the

quality of surfaces not only with this indicator. It is defined as a result of macro- and micro-irregularities, i.e. it includes roughness, accuracy of shape and dimensions (Bershadsky and Tsvetkova 1975, Ivanovsky and Vasilevskaya 1972). There are a number of similar studies, but they relate to band saws and other woodworking and furniture machines (Atanasov et al. 2018, Gochev and Atanasov 2016, Atanasov 2015, Atanasov 2014, Atanasov 2013, Kovachev 2014). However, there are no similar studies for circular machines for longitudinal cutting of logs. This determines the focus of the present study: to perform experimental studies on the influence of a basic parameter of the cutting process (feed speed) on two of the parameters for surface quality – roughness and deviation from the nominal dimensions of the obtained materials (dimensional accuracy) when operating with a circular saw machine for longitudinal cutting of logs. Furthermore, to determine the productivity of the machine as well. The obtained results should be compared with those for the most common machines in our country for similar technological operations – mobile horizontal band saws.

## METHODOLOGY

The experimental studies were conducted in the working conditions of *Pentop Company Ltd.* – town of Varshets. As an experimental unit a circular saw machine was used (*Kara Kallion Konepaja Oy – Finland*). Its general view can be seen in Figure 1. The feed movement of the circular saw machine is performed by a hydraulic carriage and a feed roller with spikes which are synchronized. As a second support and as a limiter, which determines the thickness of the successively cut board, five non-driven support rollers are used. Some of the important technical parameters of the machine are:  $D_c = 1060$  mm – the diameter of the circular saw;  $N_m = 55$  kW – the power of the electric motor driving the cutting mechanism;  $n_m = 1500$  min<sup>-1</sup> – revolutions of the motor;  $D_1 = 250$  mm – diameter of the pulley of the electric motor;  $D_2 = 370$  mm – diameter of the pulley of the cutting shaft. The cutting tool belongs to the manufacturer *BuKaRa GmbH, HW Kreissägeblätter*, Germany. Some of its linear and angular parameters are:  $\gamma/\alpha = 25/15^\circ$  – rake angle/ flank angle;  $t, h' = 4.1/5.4$  mm – pitch, tooth height; type of teeth – sterilized.



Figure 1: General view of a circular saw machine *Kara Kallion Konepaja Oy – Finland*

The material used to perform the experimental research is beech wood (*Fagus syl-*

*vatica*), which together with white pine (*Pinus sylvestris*) is a widely used wood species in our country (Petkov and Panayotov 2016,

Koynov 2016). It originates from the area of Berkovitsa municipality and is used for the production of seating furniture – chairs. For the purposes of the experiment, test pieces with a thickness of 120 mm were prepared in advance (Figure 2). In this way, the cutting height  $h$  is fixed. The density of wood materials is determined based on their mass and volume. Their moisture content was determined using a *Lignomat Tester* with a measurement accuracy of 99.8% and a contact thermometer.



Figure 2: Test specimens for conducting experimental studies

Surface roughness is determined by the indicator used in the primary cutting of wood –  $\bar{R}_m$  ( $R_v$  in BDS EN ISO 4287). For this purpose a measuring depth gauge with an indicator clock was used – in accordance with the standard BDS 4622-86. Before the start of the main research, a control measurement was performed to determine the base length.

Deviations from the nominal dimensions (dimensional accuracy) is determined using a caliper. For this purpose, the average value for the feed speed in the two passes was taken into account – through which the respective board was obtained. The obtained results are compared with the permissible for the respective thicknesses of the materials,

In the current study, the only controllable factor is the feed speed. Its average value is determined using a tape measure and a stopwatch according to the following dependence

$$v_f = \frac{L_{t.b.}}{t_i} \quad (1)$$

where  $v_f$  is feeding speed, m. s<sup>-1</sup>;  
 $L_{t.b.}$  is the length of the test body, m;  
 $t_i$  is the time for a working stroke of the machine, s.

noted in BDS EN 1313–2: 2003 Round and sawn timber – Permitted deviations and preferred sizes – Part 2: Hardwood sawn timber. The points at which both target functions are measured are a total of 20. Their arithmetic mean values are included for the analysis (Atanasov 2014, Genchev 1978). For dimensional accuracy, the absolute values of the deviations from the nominal dimensions of the obtained shaped materials were used. The distance between the measurement points  $L$  was determined by the dependence

$$L = 0,1 \cdot L_{t.b.} \quad (2)$$

Schematically, the locations for measuring the output values are shown in Figure 3.

The determination of the productivity of the machines was done in  $\text{m}^2 \cdot \text{min}^{-1}$ , because if it is determined in  $\text{m}^3 \cdot \text{min}^{-1}$ , the cutting schemes would have a great influence. For this purpose, test specimens are set aside and the operator performs the feed at a speed that is normal for the respective cutting height  $h = 120 \text{ mm}$ . The following dependence was used (Atanasov 2014)

$$Q = v_f \cdot h \quad (3)$$

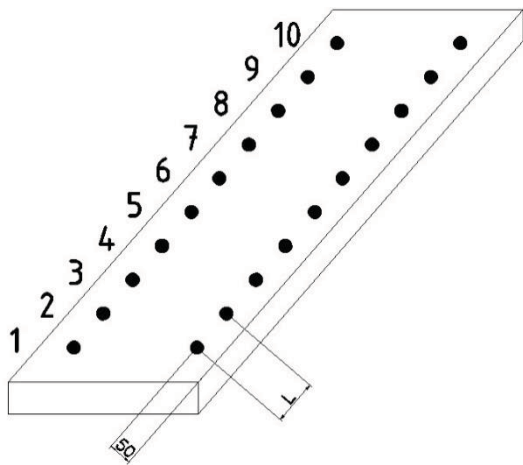


Figure 3: Points for measuring roughness and dimensional accuracy

The measurement of humidity and air temperature is performed with an instrument *MASTECH MS 6300 (China)* device. It has the ability to take into account relative humidity % RH, air temperature  $^{\circ}\text{C}$ , air flow rate  $\text{m} \cdot \text{s}^{-1}$ , noise dB and illuminance lux.

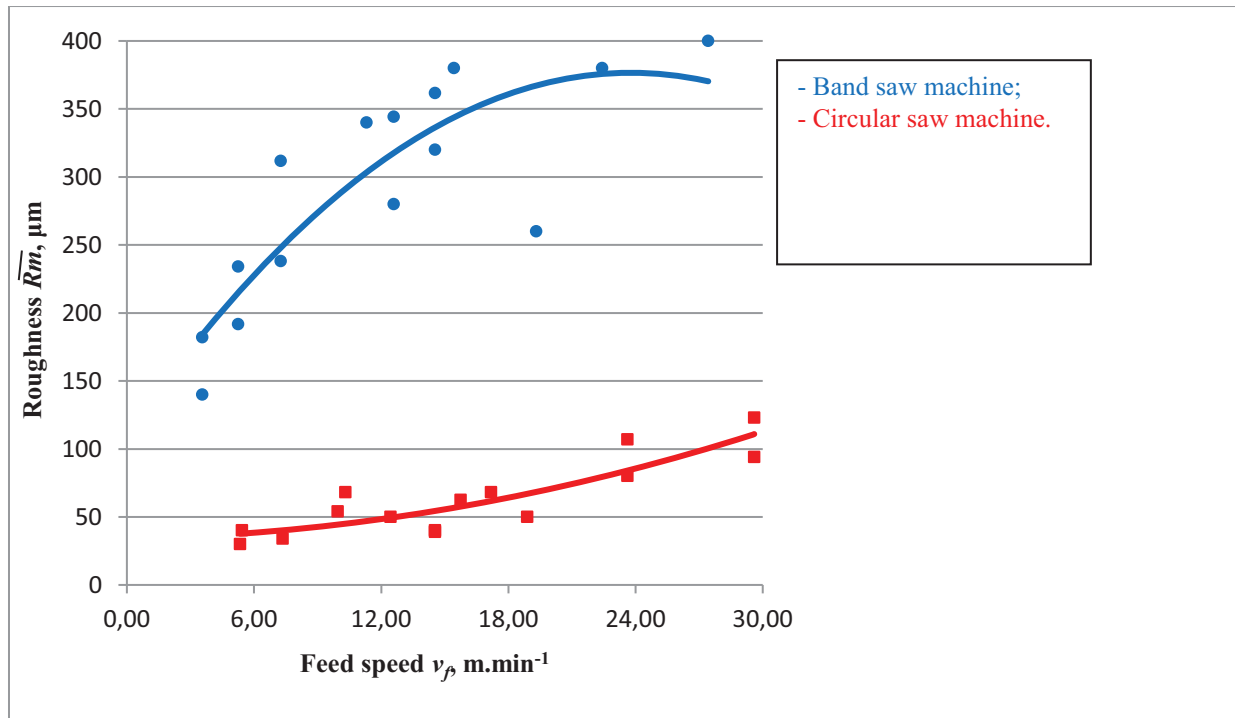
For comparison, results from a horizontal sawing machine *Arsov 90 Ltd.* was used. The operating conditions, the location of the experiments and the test samples are identical. The diameter of the band wheel of the machine is  $D_w = 630 \text{ mm}$ ;  $N_m = 7500 \text{ kW}$  – the power of the electric motor for the cutting mechanism;  $v_c = 26.4 \text{ m} \cdot \text{s}^{-1}$  – the cutting speed; the feed movement is performed manually – pushing by the operator. The cutting

tool is from *Technoles Ltd.* Its more important linear and angular parameters are:  $\gamma/\alpha = 10/30^{\circ}$  – rake angle/ flank angle;  $t, h', s' = 22/5/0.40 \text{ mm}$  – pitch, tooth height, tooth part-set size;  $s, B = 1.02/40 \text{ mm}$  – thickness, bandwidth; type of teeth – hardened.

The cutting tools of both machines were sharpened before the start of the experimental research.

## RESULTS

To perform the experimental studies around  $23.43 \text{ m}^3$  of beech wood (*Fagus sylvatica*), which was previously prepared as test samples, were used. The calculated density of the wood is  $830 \text{ kg} \cdot \text{m}^{-3}$  and the moisture content is 40.9 %. The measured average temperature during the research is  $10.3^{\circ}\text{C}$  and the relative humidity is 60.4%. This means that working conditions can be considered normal and should not affect the results. The cutting speed of the circular saw machine  $v_c$  is  $56.2 \text{ m} \cdot \text{s}^{-1}$ . It is determined by the diameters of the cutting tool and the diameters of the pulleys of the circular shaft belt drive and the revolutions of the motor. Before the start of the research some preliminary experiments were performed. Their purpose was to determine the range of variation of the studied factor – feed speed. In addition, in this case it is presented in  $\text{m} \cdot \text{min}^{-1}$ , as this makes it easier to perceive. It was found that in the circular machine the maximum feed speed during the working stroke can reach around  $100 \text{ m} \cdot \text{min}^{-1}$ , and even at such high values of this parameter, the roughness of the obtained surfaces rarely exceeded  $250 \mu\text{m}$ . In order to compare the results with a band saw machine, only those feed speed values up to  $30 \text{ m} \cdot \text{min}^{-1}$  are included to account for the effect of this parameter on the roughness. Graphically, the experimental results for the circular saw are presented in Figure 4 (the red curve).



**Figure 4: Influence of the feed speed on the roughness of the surfaces when cutting beech wood with circular saw machine and horizontal band saw machine**

The graph shows that, as expected, with the increase of the feed speed, the roughness of the obtained surfaces also increases. In addition, it is noticed that this rise is not so intense. The obtained roughness values vary in the range from 34 to 123  $\mu\text{m}$ , which corresponds to roughness classes IX, VIII and VII. At feed rates up to 8  $\text{m}\cdot\text{min}^{-1}$ , micro-irregularities do not reach 50  $\mu\text{m}$ . Subsequently, when the feed rate exceeds 10  $\text{m}\cdot\text{min}^{-1}$ , the roughness values exceed 50  $\mu\text{m}$  and remain approximately the same up to about 24  $\text{m}\cdot\text{min}^{-1}$ . After reaching this feed value, the roughness class in some cases is VII. The highest roughness value (123  $\mu\text{m}$ ) was obtained at a feed rate of 30  $\text{m}\cdot\text{min}^{-1}$ .

Figure 4 shows a curve (in the blue color) for the current target function for a mobile horizontal band saw as well. It can be seen that along its entire length this one referring to the machine with a band cutting tool significantly exceeds another. Furthermore, it can be assumed that with some approximation, the roughness of the circular

saw machine is approximately four times less in the studied feed speed range from  $\approx 4$  to  $\approx 30 \text{ m}\cdot\text{min}^{-1}$ . It follows that with this type of machine the quality of processing is much better. However, we should not miss the fact that the saw of the band saw is narrow-band – i.e. the teeth have part-set and the circular saw has sterilized teeth. From the results of similar studies presented in the literature, it can be seen that the class of roughness when cutting with this type of teeth is very low. In addition, the teeth of the circular saw wear out much more slowly and are sharpened approximately once a week. For comparison – in the case of band saw blades, the sharpening is done once during the work shift, regardless of the recommendations of the manufacturing companies – 2 hours. Last but not least is the fact that in order to compare the results, the band saw machine works in uncharacteristically high values of the feed speed.

Figure 5 (the red curve) shows the influence of the feed speed on the dimensional accuracy when cutting beech logs with a circular saw machine. It can be seen from the figure that even at the highest feed speeds, the deviations from the nominal dimensions do not exceed 2 mm. The only deviation from this trend is achieved at a feed rate of  $28.6 \text{ m}\cdot\text{min}^{-1}$  – 2.13 mm. Such values are within the tolerances of 30 mm thick materials. In addition, it can be seen from the figure that up to a feed speed of  $12 \text{ m}\cdot\text{min}^{-1}$ , the deviations in dimensional accuracy do not exceed 1 mm, and after this speed the dimensions hardly change their values.

The same figure, but in blue color, shows the horizontal band saw curve obtained under the same conditions. It shows that even at the lowest values of the feed speed, the machine shows relatively bad values of the deviations from the nominal size of the boards. The reason for this is the smaller

thickness of the band saw blade, which has an adverse effect on its stability. As we know from the "Wood Cutting" theory, when reaching the critical cutting force, the band saw blade loses its stability and begins to bend. At feed speeds less than  $10 \text{ m}\cdot\text{min}^{-1}$ , deviations from the nominal dimensions reach about 3.4 mm. These results can be considered unsatisfactory, even taking into account the fact that the machine is designed for primary cutting, and the accuracy requirements for these machines are low. Subsequently, when the feed speed increases above  $20 \text{ m}\cdot\text{min}^{-1}$ , the deviations from the nominal dimensions exceed even 5.5 mm. After consulting the standard "BDS EN 1313–2: 2003 Round and sawn timber – Permitted deviations and preferred sizes – Part 2: Hardwood sawn timber" it is clear that for the respective thickness these deviations are outside the permissible limits.

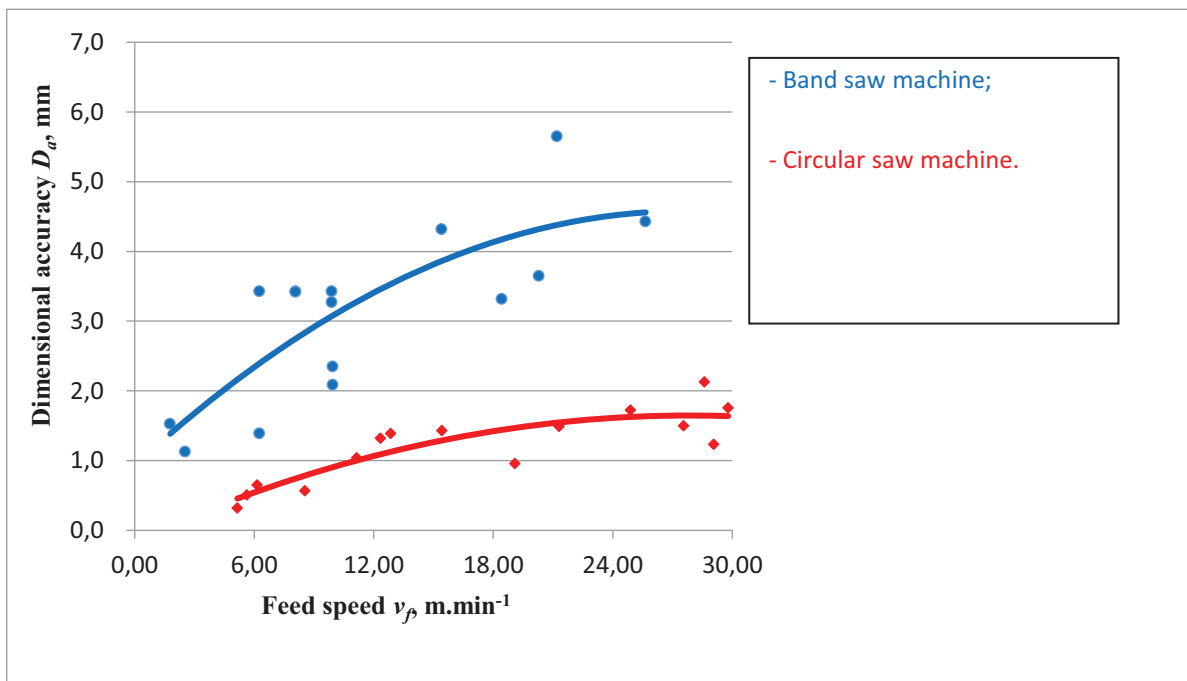


Figure 5: Influence of the feed speed on the dimensional accuracy when cutting beech wood with circular saw machine and horizontal band saw machine

The productivity of the machine is determined by its arithmetic mean value from the cutting of five test pieces. Each of the results

is obtained by multiplying the feed speed and the cutting height – formula 3. The feed speed is determined by the machine operator

– ie. the normal speed for the respective cutting height when cutting beech wood. Figure 6 shows the average productivity of both machines in  $\text{m}^2 \cdot \text{min}^{-1}$ . This shows that the machine with a circular cutting tool has about eight times higher productivity. The main reason for this is the better stability of the cutting tool, which is a result of its greater thickness. This greater thickness leads to the main

disadvantage of the machine – the small number of boards that can be obtained from specific test bodies for research. Graphically, the cutting schemes for both machines can be seen in Figure 7 A and B. It is noticed that with the circular machine the number of boards is less by one.

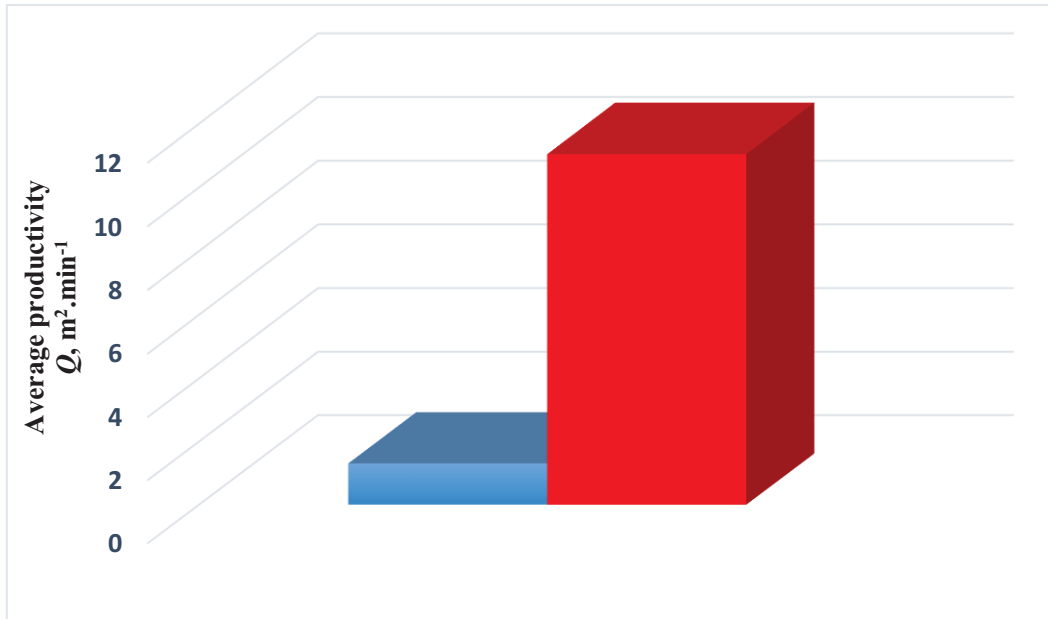


Figure 6: Average productivity of the tested machines

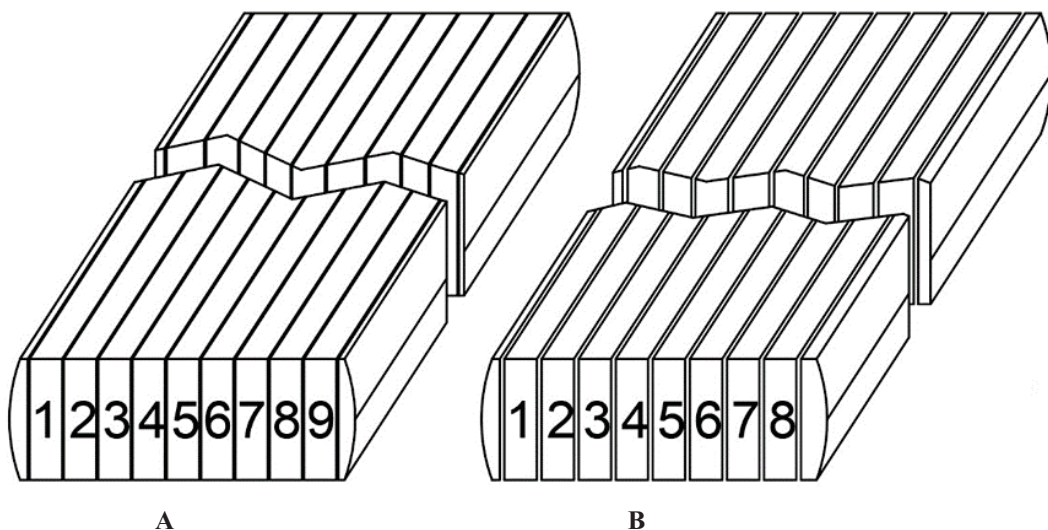


Figure 7: Cutting schemes of test specimens (A – band saw machine, B – circular saw machine)

The results presented in this paper refer to machines for primary cutting of logs. They are received in real manufacturing conditions

and comparing them with research by different authors would be a difficult task. This is

especially true for the circular saw, as the operating conditions, the purpose of the tested machines, the factors and studied parameters, the materials, the type of cutting tools, etc. are very different from other studies. Such are, for example, the researches of *Budakci et al. 2011, Aguilera 2011, Li et al. 2017, Kminiak and Gaff 2015.*

### CONCLUSION

Based on the conducted experimental research in cutting beech with a circular machine in the production conditions of the company *Pentop Ltd.*, the following conclusions and recommendations can be made:

1. The feed speed has a significantly greater influence on the studied target functions in the machine with a band saw blade. For comparison, the roughness is relatively four times greater, and the deviations from the nominal dimensions about three times;
2. In terms of productivity, when all conditions are equal, the circular saw machine is approximately eight times superior to the band saw machine;
3. Greater attention should be paid to the preparation of the band saw blades, as a comparison with previous experimental studies shows that the results obtained are significantly worse.
4. The only major disadvantage of the circular saw machine is the significantly wider cut, which converts some of the shaped materials into chips.
5. It is necessary in the future to make more in-depth studies, including deviations from the straightness of the slot, the influence of the type of cut-

ting tool (type of teeth, linear, angular parameters, etc.), cutting power and force, power consumption, as well as when cutting different wood species. Last but not least, to carry out comparative studies with a vertical sawing machine for logs.

### REFERENCES

- AGUILERA A. 2011. Cutting energy and surface roughness in medium density fiberboard rip sawing, *Eur. J. Wood Prod.*, 69:11–18. DOI 10.1007/s00107-009-0396-z.
- ATANASOV V. 2014. A Study on Operational Indicators of Mobile Horizontal Bandsaws, Ph.D. Thesis, University of Forestry, Sofia, 196 p. (in Bulgarian).
- ATANASOV V., M. TODOROV, V. SPASOV. 2018. Research on the Quality of Processing with a Horizontal Bandsaw, *Innovations in Forest Industry and Engineering Design*, 1/2018, ISSN 1314-6149, e-ISSN 2367-6663, pp. 5–11.
- ATANASOV V. 2015, Research of the processing quality in cutting poplar logs with different narrow bandsaw blades, *International Scientific and Technical Conference „WOOD TECHNOLOGY AND PRODUCT DESIGN"*, Ss. Cyril and Methodius University of Skopje, Vol. II, ISBN 978-608-4723-01-1. pp. 17–25.
- ATANASOV V. 2013. Research on the quality of processed surfaces when cutting spruce logs with narrow band saw blades, *Innovations in Forest Industry and Engineering Design*, 1/2013, ISSN1314-6149, pp. 66–70.
- BERSHADSKY A., TSVETKOVA N. 1975. *Wood Cutting*, Vysheyshaya Shkola, Minsk, 1975, 304 p. (in Russian).
- BUDAKCI M., ILCE A., KORKUT D., GURLEYEN T. 2011. Evaluating the surface roughness of heat-treated wood cut with different circular saws, *BioResources* 6(4), 4247–258.
- FILIPOV G. 1979. *Woodworking Machines*. Zemizdad. 390 p (in Bulgarian).
- GENCHEV G. 1978. Research of the Process of Wood Cutting by Resaw Band Saw with Roller Feed Mechanism, PhD Thesis, Sofia, 256 p (in Bulgarian).
- GOCHEV ZH., V. ATANASOV. 2016. Sawing of Douglas Fir Logs with Narrow Band Saw Blades in Winter Conditions, *Innovations in Forest Industry and Engineering Design*, Sofia, 1/2016 (9) pp. 5–12, ISSN1314-614.

- IVANOVSKY E., VASILEVSKAYA P., LAUTIER M. 1972. New Researches of Wood Cutting, Timber Industry, 1972, 128 p. (in Russian).
- KMINIAK R., GAFF M. 2015. Roughness of Surface Created by Transversal Sawing of Spruce, Beech, and Oak Wood, BioResources 10(2), 2873–2887.
- KOVACHEV G. 2014. Dynamics of the cutting mechanism of a milling machine with lower spindle position. Ph.D. Thesis, University of Forestry, Sofia, 2014, 188 p. (in Bulgarian).
- KOYNOV D. 2016. Quantitative Yields at Cutting of Scots Pine (*Pinus sylvestris* L.) Stems Depending on the Thickness and Length of Details and Disadvantages of Wood. Innovations in Forest Industry and Engineering Design, Sofia, 1/2016 (9) pp. 93–98, ISSN1314-614.
- LI W., ZHANG Z., PENG X., LI B. 2017. The influences of circular saws with sawteeth of mic-zero-degree radial clearance angles on surface roughness in wood rip sawing, Annals of Forest Science, 74: 37. DOI 10.1007/s13595-017-0632-3.
- OBRESHKOV P. 1995. Woodworking Machines, Part 1, Sofia – 1995, 206 p (in Bulgarian).
- PETKOV T., PANAYOTOV P. 2016. Correlation between Physical and Mechanical Properties of the Wood. The VII-th International Scientific and Technical Conference Innovations in Forest Industry and Engineering Design. Sofia, 2016, 1: 13–20. ISSN 1314-6149. e-ISSN 2367-6663.
- BDS 4622:1986 – Wood Products and Wood Materials. Surface Roughness. Method to Determine the Parameters (in Bulgarian).
- BDS EN 1313–2: 2003 Round and sawn timber – Permitted deviations and preferred sizes – Part 2: Hardwood sawn timber.
- BDS EN ISO 4287. Geometrical product specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters (ISO 4287:1997).



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