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Machining parameters of the patented wood, lightweight stabilised blockboard

Rihards Roziņš[1], *Uldis Spulle[1], Andis Ābele[1] and Vilnis Jakovļevs[2]
[1]Institute of Civil Engineer and Woodworking, Latvia University of Life Sciences and Technologies, Dobeles iela 41, Jelgava, LV-3001, Latvia
[2]Latvia University of Life Sciences and Technologies Malnava College, Kļavu iela 17, Malnava, Malnavas pagasts, Ludzas novads, LV-5750, Latvia

Abstract. Since the introduction of wood cellular material, or Dendrolight®, the process of creating dimensionally stable wood panels (Berger *et al*., 2016) has evolved towards the creation of a similar, but significantly different new material - Lightweight Stabilised Blockboard (LSB). It was patented (Roziņš, M. Vašuks & P. Vašuks, 2014a) with the invented profiled solid wood boards (Roziņš, M. Vašuks & P. Vašuks, 2014b). The LSB design has introduced a smaller groove or kerf height, which hypothetically allows for a reduction in energy consumption during its manufacturing process. Considering that LSB is a new material, most suitable parameters of cutting regime for the LSB mechanical machining have not been developed. To develop machining processes for LSB, it is necessary to determine the optimal cutting tool, machine parameters, expected feed speed and cutting power. The study analyses the parameters of cutting regime that affect the cutting power, and performs theoretical calculations that reveal the expected and most suitable cutting process indicators in the industrial production of LSB, as well as compares the machining of LSB and Dendrolight®. A new evaluation parameter has been introduced that characterises the ratio between the cutting power and the permissible feed speed. It was concluded that grooving LSB lamellae requires significantly less cutting power, and that higher feed speeds are possible compared with the grooving of analogous Dendrolight® lamellae. However, the cutting power required for the LSB grooving is still quite energy-intensive, which potentially limits the possible width of LSB lamellae and the number of simultaneously operating cutting tools.
Key words: wood cellular material, Lightweight Stabilised Blockboard, Dendrolight®, wood machining, cutting power, feed speed.

Introduction

A novel wood-based material was introduced 15 years ago, when the production of wood cellular material – Dendrolight® – began in Latvia. Dendrolight® demonstrated remarkable improvements in the performance characteristics of solid wood (Iejavs & Spulle, 2016). Through purely mechanical modification techniques, it was possible to significantly enhance the dimensional stability of wood panels, thereby addressing one of the long-standing limitations of natural wood: its tendency to deform under fluctuating environmental conditions (Iejavs, 2025). In typical indoor climates, characterised by periodic changes in relative humidity and temperature, the modified material exhibited exceptional resistance to warping, flexing and bulging. These improvements made the material particularly promising for a wide spectrum of applications, ranging from standard furniture boards to complex structural and architectural components (Labans & Kalnins, 2012). Despite these advantageous properties, the material eventually lost much of its industrial and commercial attractiveness. This decline was not caused by the loss in relevance, as the problems it addressed remain critical in both interior and construction applications today (Labans, Kalnins, & Bikovs, 2012). One of the most significant limiting factors was the relatively high process and energy intensity involved in its production. This was partly caused by the loss of material volume to sawing in the late production stage, where up to 15 %

* Corresponding Author's email address: uldis.spulle@lbtu.lv

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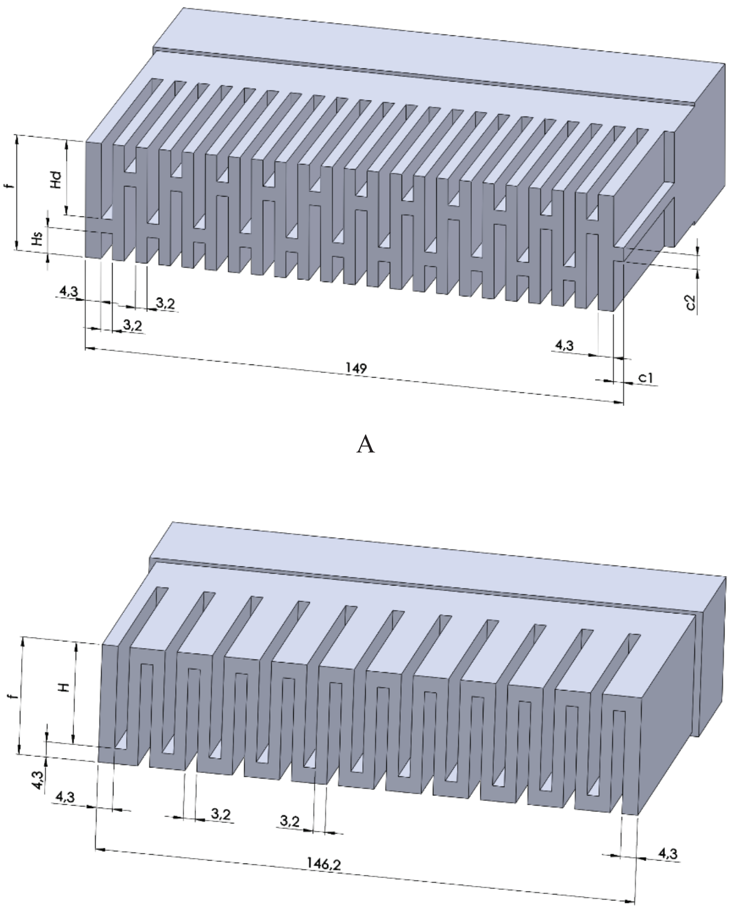
of nearly finished core material was turned into dust by the saw blades as it was cut into relatively thin sheets. While the technological advances achieved through mechanical means remain highly relevant, their practical implementation was limited by economic constraints directed by energy and process efficiency. This lesson underlines the importance of integrating not only material science innovations but also process optimisation strategies when evaluating the real-world viability of new wood-based materials (Berger *et al.*, 2016). From an industrial perspective, machining costs are primarily time-dependent; therefore, production economics necessitate running equipment at the highest feasible throughput while simultaneously ensuring product quality and energy efficiency. Production at scale cannot be run slowly without severely impacting the overall cost efficiency. We can look at a very trivial example: the production of a wooden spoon. An artisan can produce a spoon with zero energy spent (besides from physical effort), but it will be slow, whereas a specialised machine can do it quickly, but with high power consumption. It may seem that the machine uses a relatively huge amount of energy; yet in the end, the product coming from the faster process will be more economical. It is quite likely that the energy used by a light bulb and heating in in the artisan's room is more than the 50 kW milling machine uses to make the spoon in less than ten seconds. The time that product spends while being produced in many cases is the main contributing factor in loss of economy.

Therefore, it is of utmost importance for any newly engineered wood product to look at the invention through the prism of the maximum production speed that can be achieved with readily available powerful machines, and how far the product is from the plateau where the most optimal scaling scenario is achieved by parallelisation of production by stacking multiple parallel production lines. Lightweight Stabilised Blockboard (LSB) material, compared with Dendrolight®, is only stable in plane, but in the thickness direction it swells and shrinks as solid wood would, since the thickness for wood panel compared with other dimensions is relatively small. The effect of this deformation proved to be insignificant and panels made of this material have shown to perform excellently in furniture even after multiple years of use. This compromise – to allow solid wood like deformations in the thickness direction, allowed to reduce the necessary processing operation amount by 50%. It increased the volumetric yield input material to output product by about 30 %. The overall design of the core is new and the profiles making up the core were designed to allow for faster production speeds, therefore making the overall production more efficient. Machine energy consumption to produce such profile for core of wood composite panel is significant, even when using saw blades with a relatively small cutting width (approximately 3 mm). It is well known that cutting energy consumption is affected not only by the width of the cutting area (Elloumi *et al*., 2023), but also by the cutting velocity (Koleda, Barcík, & Nociarová, 2019), rake angle and feed speed (Koleda *et al*., 2024), as well as the cutting depth or height of the kerf (Tiryaki, Malkocoğlu, & Ozşahin, 2016; Merhar, Bjelić, & Hodžić, 2024). If all or any of these parameters increase, then the cutting power consumed also increases (Barcík, Pivolusková, & Kminiak, 2008; Marthy & Cismaru, 2009; Nasir & Cool, 2019; Pinkowski *et al*., 2024). This means that the resistance created by transporting chips faster and further increases, which also causes greater wear on the cutter during the cutting process (Krilek *et al.*, 2024). However, it should be noted that cutting power consumed or material throughput does not uniquely explain the cutter wear, especially if the cutter wear is weighted against product volume processed. For example, an increase of cutting power resulting from an increase of a cutting width does not mean that the intensity of the cutter's wear also increases under such conditions, since the resistance of the wood is overcome by the longer cutting edge of the cutter. The cutter wear and cutting power increase most significantly as the feed speed increases (Ispas *et al.*, 2025), but the kerf height also has a significant impact on the cutting power (Ivanovskiy, 2021). Core lamellae of LSB has a smaller height of kerfs (Roziņš *et al*., 2023), when comparing LSB and Dendrolight®. Since the height of kerfs of LSB is reduced, the amount of energy required to produce grooved lamellae for wood cellular material core is also reduced. This leads to the research hypothesis: LSB production consumes less power compared with the production of Dendrolight®. Development of materials with similar properties to Dendrolight® is still ongoing, with the goal of creating potential "breathing" products and increasing the production efficiency of existing products. The new product has been created as a result – the LSB, patented in Latvia by the ARB Pope Ltd company. (Roziņš, M. Vašuks, & P. Vašuks, 2014a). Compared with Dendrolight® type boards, LSB offers significant economical and minor technical gains. The main differences of the LSB compared with Dendrolight® are that lamellae making up the core have groove depths reduced thanks to double-sided milling in the longitudinal direction of the boards. This kind of cross section results in less demanding energy requirements for cutting procedures compared with Dendrolight®. Other benefits of more distributed ribs within the profile include more uniform contact surface with similarly sized contact lines for gluing. This allows for better adhesion at lower pressing pressures enabling option to use higher throughput and smaller initial investment in pressing machinery such as vacuum presses. Another benefit is an increased panel compression strength via reduced rib slenderness, and the increased shear strength of the product. The LSB is a completely new material. No research has been delivered on the mechanical machining of LSB until now. The purpose of the research is to direct and to choose optimal cutting tools and machine parameters for the core profile milling, and to calculate initial feed speed and cutting power requirements that will govern the process of choosing the machinery. In addition, these parameters of such cutting procedures are compared with the machines that are available without special construction characteristics and without purpose building them specifically for the LSB production needs. The tasks of the research are to determine the available drive motor powers and cutting power for LSB production, to calculate the permissible feed speed and to compare the determined indicators between the LSB and Dendrolight® taking into account the desired feed speed.

Materials and Methods

Pine (*Pinus Sylvestris* L.) timber with a moisture content of 12% is intended to create the core (inner) layers of the LSB according to the principle scheme of producing LSB, published previously (Roziņš *et al*., 2023).

The profile and geometric parameters of the grooved lamellae of the LSB's core layer can be seen in Fig. 1A, but the grooved lamellae of of the Dendrolight® core layer can be seen in Fig. 1B.



A

B

Figure 1. Differences in the grooved lamellae of the core layer of wood cellular materials (mm):

A – LSB; B – Dendrolight®; f – thickness of lamellae of the core layer (after surface's planing); Hd – height of deep grooves (kerfs); Hs – height of shallow grooves (kerfs); H – height of grooves (kerfs); c1 – width of side cam (c1 = 2.8); c2 – height of side cam (c2 = 4.0).

The parameters of LSB lamellae and saw blades required for calculations are indicated in Table 1.

Calculations of the feed speed, cutting force and cutting power were made using the formulas given as follows.

Feed speed depending on the load acting on the cutter (modified based on Tuherm & Ābele, 2014):

$$u_1 = \frac{s^2 \cdot z \cdot n}{3000}, \tag{1}$$

where: u_1 is feed speed depending on the load acting on the cutter, m min^{-1};
s is the body thickness of saw blade, mm;
z is the number of saw blade's cutters;
n is the rotation frequency of the spindle, min^{-1}.

Rotation frequency of the spindle (modified based on Tuherm & Ābele, 2014):

$$n = \frac{v \cdot 6000}{\pi \cdot D}, \tag{2}$$

where: n is rotation frequency of the spindle, min^{-1};
v is the cutting velocity, m s^{-1};
π is the constant ($\pi = 3.14$);
D is the cutting circumference of the saw blade, mm.

Feed speed depending on the stability of the saw blade (modified based on Tuherm & Ābele, 2014):

$$u_2 = \frac{1900 \cdot s \cdot \sqrt{s}}{\sqrt[3]{H^2 \cdot D}}, \tag{3}$$

where: u_2 is the feed speed depending on the stability of the saw blade, m min^{-1};
s is the body thickness of the saw blade, mm;
H is the height of the kerfs, mm;
D is the cutting circumference of the saw blade, mm.

Feed speed depending on the drive motor power (based on Tuherm & Ābele, 2014):

$$\frac{K \cdot b \cdot H \cdot z_\Sigma \cdot u_3}{60000} \leq G_0 \cdot \eta, \tag{4}$$

where: u_3 is the feed speed depending on the drive motor power, m min^{-1};
K is the specific cutting work, J cm^{-3};
b is the kerf width of the saw blade, mm;
H the is height of the kerfs, mm;
z_Σ is the total number of grooves (kerfs) to be cut simultaneously;
G_0 is the drive motor power (nominal), kW;
η is the efficiency ratio of power transmission ($\eta = 0.7$).

Specific cutting work is calculated depending on chip the thickness:

- if the chip thickness is grater or equal to 0.1 mm (modified based on Tuherm & Ābele, 2014):

Table 1

Parameters of the cutting regime of LSB

Parameter	Values					
Thickness of lamellae of the core layer (after surface's planing), mm	18		28		33	
Height of grooves (kerfs) H, mm	12	2	19	5	21.5	7.5
Number of grooves z_Σ	11					
Width of lamellae of the middle layer (after surface's planing), mm	149					
Kerf width of saw blade b, mm	3.2					
Body thickness of saw blade s, mm	2.2					
Clearance angle of tooth of saw blade α, degree	15					
Sharpness angle of tooth of saw blade β, degree	55					
Rake angle of tooth of saw blade γ, degree	20					
Cutting angle of tooth of saw blade δ, degree	70					
Number of saw blade's cutters z	24					
Cutting velocity of saw blade v, m s^{-1}	70					
Desired feed speed u, m min^{-1}	120					

$$K = \left(K_{pr} + \frac{(4 + 0.036 \cdot \varphi) \cdot 1.45}{\frac{1000 \cdot u_3 \cdot \sin\varphi}{n \cdot z}} \right) + \frac{0.6 \cdot H}{b}, \quad (5)$$

- if the chip thickness is less than 0.1 mm (modified based on Tuherm & Ābele, 2014):

$$K = \left(K_{pr} + \left(8 + \frac{0.65}{\frac{1000 \cdot u_3 \cdot \sin\varphi}{n \cdot z}} \right) \cdot (4 + 0.036 \cdot \varphi) \right) + \frac{0.6 \cdot H}{b}, \quad (6)$$

where: K is the specific cutting work, J cm^{-3};
K_{pr} is the pressure on the front surface of the cutter in the chip formation zone, N mm^{-2};
φ is the angle between the cutting and feed direction, degrees;
u_3 is the feed speed depending on the drive motor power, m min^{-1};
b is the kerf width of saw blade, mm;
H is the height of kerfs, mm;
z is the number of saw blade's cutters;
n is the rotation frequency of the spindle, min^{-1}.

Pressure on the front surface of the cutter in the chip formation zone (Tuherm & Ābele, 2014):

$$K_{pr} = (0.2 + 0.0039 \cdot \varphi) \cdot \delta + (0.07 + 0.0014 \cdot \varphi) \cdot v - 5.4 - 0.158 \cdot \varphi, \quad (7)$$

where: K_{pr} is the pressure on the front surface of the cutter in the chip formation zone, N mm^{-2};
φ is the angle between the cutting and feed direction, degrees;
δ is the cutting angle of a tooth of the saw blade, degree;
v is the cutting velocity, m s^{-1}.

Angle between the cutting and feed direction (modified based on Tuherm & Ābele, 2014):

$$\varphi = \cos^{-1}\left(\frac{D - H}{D}\right), \quad (8)$$

where: φ is the angle between the cutting and feed direction, degrees;
D is the cutting circumference of the saw blade, mm;
H is the height of the kerfs, mm.

Feed per tooth (Tuherm & Ābele, 2014):

$$u_z = \frac{1000 \cdot u}{n \cdot z}, \quad (9)$$

where: u_z is the feed per tooth, mm. u is the feed speed, m min$^{-1;}$
n is the rotation frequency of the spindle, min^{-1};
z is the number of saw blade's cutters.

Chip thickness (Tuherm & Ābele, 2014):

$$h_{sk} = u_z \cdot \sin\varphi, \quad (10)$$

where: h_{sk} is the chip thickness, mm;
φ is the angle between the cutting and feed direction, degrees.

Cutting force (modified based on Tuherm & Ābele, 2014):

$$P = \frac{K \cdot b \cdot H \cdot u \cdot z_\Sigma}{60 \cdot v}, \quad (11)$$

where: P is the cutting force, N;
K is the specific cutting work, J cm^{-3};
b is the kerf width of the saw blade, mm;
H is the height of the kerfs, mm;
u is the feed speed, m min^{-1};
z_Σ is the total number of grooves (kerfs) to be cut simultaneously;
v is the cutting velocity, m s^{-1}.

Cutting power (modified based on Tuherm & Ābele, 2014):

$$G = \frac{K \cdot b \cdot H \cdot u \cdot z_\Sigma}{60000}, \quad (12)$$

where: G is the cutting power, kW;
K is the specific cutting work, J cm^{-3};
b is the kerf width of the saw blade, mm;
H is the height of kerfs, mm;
u is the feed speed, m min^{-1};
z_Σ is the total number of grooves (kerfs) to be cut simultaneously.

Results and Discussion

To calculate the feed speed, cutting force and cutting power, it is also necessary to determine the possible feed rate, the optimal or suitable cutting circumference's diameter of the cutting tools (saw blades) and the power of the spindle drive motors. These are in addition to the parameters specified

Table 2
The effect of the cutting circumference diameter of the sawblade on the feed speed resulting from the drive motor power

Parameter	Values					
Cutting circumference diameter of saw blade *D*, mm	200	210	250	300	320	350
Height of grooves (kerfs) *H*, mm	12	12	12	12	12	12
Number of grooves z_{Σ}	11	11	11	11	11	11
Drive motor power G_0, kW	45	45	45	45	45	45
Feed speed (permissible) u_3, m min^{-1}	62[A]	67[A]	84[A]	100[A]	106[A]	113[A]

[A] – calculated with equations 4 to 8.

in the “Materials and Methods” section of this publication.

The best solution for grooving lamellae of the core layer of LSB is four-sided moulder machines. They are capable of both planing surface planes and grooving at the same time. If cutting power increases with the increasing feed speed (Nasir & Cool, 2019; Fekiač *et al.*, 2022) then it can be concluded that with the higher power of the drive motors, a higher possible feed speed can be achieved. One of the largest powers for drive motors is offered for four-sided moulders from the company “Leadermac”, namely up to 45 kW per spindle (Leadermac). Therefore, it can be assumed that the power of each drive motor for LSB lamellae grooving are 45 kW. Assuming that the grooving of each wide face occurs by simultaneously cutting both deep and shallow grooves (but with two separate cutting tool blocks on each wide face), the required number of spindles is eight (if planing of one narrow face is performed with profiled knives that perform both surface straightening and side cam development) or nine spindles (if surface straightening and side cam development of one narrow face are performed on separate spindles). In most cases, considering that four-sided moulder’s manufacturers offer to equip machines with up to ten or even more spindles in standard versions, such a number of spindles is possible.

It can be concluded, based on information from leading manufacturers, that the possible cutting-circumference diameters are possible from 200 to 350 mm (Freud, Leuco, Leitz), for cutting tools with the required cutting width of 3.2 mm. In order to optimally use the available power of a drive motor (to achieve the highest possible permissible feed rate), it is desirable to use saw blades with the largest possible cutting circumference diameter (Table 2). Because this reduces the angle between the cutting vector of saw blade’s tooth and the feed vector or the longitudinal direction of the wood fibres (Ābele, 2017; Merhar, Bjelić, & Hodžić, 2024). However, the larger cutting circumference diameter

Table 3
Calculation results of the permissible feed speed if the cutting circumference diameter of the saw blades are 300 mm

Parameter	Values					
Thickness of lamellae of the core layer (after surface’s planing), mm	18		28		33	
Height of grooves (kerfs) *H*, mm	12	2	19	5	21.5	7.5
Number of grooves z_{Σ}	11	11	11	11	11	11
Feed speed depending on the load acting on the cutter u_1, m min^{-1}	172	172	172	172	172	172
Feed speed depending on the stability of the saw blade u_2, m min^{-1}	176	583	130	316	119	241
Feed speed depending on the drive motor power u_3, m min^{-1}	100	1383	33	420	26	229
Feed speed (permissible) *u*, m min^{-1}	100	172	33	172	26	172

of a saw blade, the more permissible feed speed is lost depending on the stability of the saw blade if the saw blade thickness is not changed (Li *et al.*, 2016; Nasir, Mohammadpanah, & Cool, 2020). However, the width of the kerf needs to be relatively small and it is not possible to change it for the new LSB product according to the profile of a core layer (Fig. 1A). Saw blades with a cutting circumference diameter of 350 mm are offered by only one of the reviewed manufacturers (Leitz). Therefore, saw blades with a cutting circumference diameter of 320 mm are more widely available, as they are offered by all the reviewed manufacturers (Freud, Leuco, Leitz). However, it is recommended to choose saw blades with a cutting circumference diameter of 300 mm, as larger diameter cutting tools are rarely compatible with four-sided moulders (Leadermac).

Based on the calculation results from equations 1 to 8 (Table 3), the possible feed speed is relatively low (compared with the desired feed speed in Table 1) when machining all 11 required grooves at once (especially for lamellae with thickness of 28 and 33 mm). Considering that the four-sided moulder is capable of working at a feed rate of up to 200 m min^{-1} (Leadermac), a feed rate of, for example, 26 m min^{-1} will not be able to load the machine effectively enough. The calculation results indicate that a significantly higher drive motor power is required, exceeding the assumed drive motor power by at least two times. Considering that the power of the drive motor is at its maximum (available in standard without special construction) in this situation (Leadermac), the solution is to cut the grooves in two separate passes so that the number of grooves cut simultaneously is two times less. There is a need for several four-sided machines placed one after the other in order to achieve the solution where the number of cuts to be made simultaneously and the depth of grooves (kerf) are reduced.

Considering that the permissible feed speed for shallow grooves, depending on the drive motor power, exceeds the permissible feed speed value by up to eight times (Table 3), it is recommended to also cut shallow grooves simultaneously with deep cuts. As a result, the number of grooves (kerfs) to be cut simultaneously will increase back by two times again, but the load will not increase by two times because not all grooves are having the same height. The total number of grooves (deep + shallow) on each face is 22, so they cannot be symmetrically divided by two. On one side, a combination of six deep and five shallow grooves is formed, and on the other side, a combination of five deep and six shallow grooves is formed. Although the total number of grooves is the same, the load on the first side will be greater because the sum of cutting depths there is higher, and the higher the cutting depth, the higher the cutting force required (Jin *et al.*, 2025). Further calculations should be made for the highest load. However, this changes the depth of the grooves (kerfs), which must be taken into account as the average height of the grooves (kerfs) in the calculations. The multiplication between the value of an average height of grooves (kerfs) and the number of grooves (kerfs) is equivalent to the sum of actual kerf heights:

$$H_m = \frac{H_d \cdot m_d + H_s \cdot m_s}{z_\Sigma}, \tag{13}$$

where: H_m is the average height of grooves (kerfs), mm;
H_d is the actual height of deep grooves (kerfs), mm;
m_d is the number of deep grooves (kerfs) to be cut simultaneously ($m_d = 6$);
H_s is the actual height of shallow grooves (kerfs), mm;
m_s is the number of shallow grooves (kerfs) to be cut simultaneously ($m_s = 5$);
z_Σ is the total number of grooves (kerfs) to be cut simultaneously ($z_\Sigma = 11$).

Average height of grooves (kerfs) for 18 mm thickness of lamellae of the core layer:

$$H_m = \frac{12 \cdot 6 + 2 \cdot 5}{11} = 7.455 \text{ mm}$$

Average height of grooves (kerfs) for 28 mm thickness of lamellae of the core layer:

$$H_m = \frac{19 \cdot 6 + 5 \cdot 5}{11} = 12.636 \text{ mm}$$

Average height of grooves (kerfs) for 33 mm thickness of lamellae of the core layer:

$$H_m = \frac{21.5 \cdot 6 + 7.5 \cdot 5}{11} = 15.136 \text{ mm}$$

Updating the calculations of the permissible feed speed (calculations results from equations 1 to 8), Table 4 shows that the possible feed speed is 1.7 to 2.5 times higher than before (Table 3), when the number of grooves (kerfs) to be cut simultaneously is reduced to six deep and five shallow grooves. In addition, the maximum permissible feed speed for the LSB lamella grooving is 2.8 to 4.2 times higher compared with the maximum permissible feed speed for the Dendrolight® lamella grooving. Consequently, the LSB production process is correspondingly more

Table 4

Comparison of the calculation results of the permissible feed speed in the production of LSB and Dendrolight® (the cutting circumference diameter of the saw blade is 300 mm)

Parameter	Values					
Type of wood cellular material	LSB			Dendrolight®		
Thickness of lamellae of the core layer (after surface's planing), mm	18	28	33	18	28	33
Height of grooves (kerfs) H, mm	7.455[A]	12.636[A]	15.136[A]	13.700[B]	23.700[B]	28.700[B]
Number of grooves z_{Σ}	11[C]	11[C]	11[C]	11[D]	11[D]	11[D]
Feed speed depending on the load acting on the cutter u_1, m min^{-1}	172	172	172	172	172	172
Feed speed depending on the stability of the saw blade u_2, m min^{-1}	176	130	119	161	112	98
Feed speed depending on the drive motor power u_3, m min^{-1}	231	90	61	60	19	14
Feed speed (permissible) u, m min^{-1}	172	90	61	60	19	14

[A] – equal to an average height of grooves (kerfs) (H_m; equation 13).
[B] – equivalent height of kerf, which is equal to the residual between the thickness of lamellae of the core layer (after surface's planing) and 4.3 mm (thickness of the bottom wall of a wood cell).
[C] – number of grooves (kerfs) to be cut simultaneously is equal to the sum of six deep and five shallow (together 11) grooves.
[D] – all grooves have the same height within the respective thickness of the same lamellae.

productive, at least at the lamella processing stage. However, the desired feed speed (Table 1) is not achieved and it is limited to 61 m min^{-1} (two times less compared with the desired feed speed) because it is necessary to further reduce the cutting power in calculations for the production of LSB. It is important to make the calculation results of the feed speed comparable between LSB and Dendrolight®, therefore it is assumed that the thickness and width of the lamellae of Dendrolight® are equal to the corresponding dimensions of the lamellae of LSB. It is also assumed that the number of grooves and the parameters of the cutting tools are identical. The only difference that is specific to Dendrolight® is that Dendrolight® has a higher groove (kerf) height, which is calculated assuming that the thickness of a residual wall of wood cell is 4.3 mm in this study (Fig. 1B).

The results of the calculations of the cutting force and cutting power (equations 9 to 12), required in the grooving process of lamellae of LSB and Dendrolight®, (Table 5) indicate that a lower cutting power is formed only for one of the LSB lamella's thicknesses (18 mm), while the other lamella's thicknesses have the same cutting force and cutting power. It can seemingly be concluded that there is no saving of cutting power in LSB production compared with Dendrolight® production. It can be erroneously concluded that the hypothesis, raised in the introduction, that LSB production consumes less power has not been confirmed. It should be noted that the permissible feed speed for lamellae with thickness of 28 and 33 mm is limited by the available drive motor power, which is the same for both wood cellular materials. Therefore, it is logical that the expected consumed cutting power is the same, because during the cutting process it is only possible to consume as much power as the drive motor is capable to provide. This is the useful power (resulting from equation 4), and can be calculated by the following equation:

$$G_u = G_0 \cdot \eta, \tag{14}$$

where: G_u is the useful drive power, kW;
G_0 is the drive motor power (nominal), kW;
η is the efficiency ratio of power transmission ($\eta = 0.7$).

Comparing the useful power obtained from equation 14 and the calculation results of Table 5, it can be seen that the cutting power is indeed equal to the useful power (if nominal drive motor power is equal to 45 kW and the efficiency ratio of power transmission is equal to 0.7). Cutting power savings can be seen by estimating how much power is required to provide one unit of feed speed. This indicator can be calculated with the following equation:

Table 5

Calculation results of cutting force and cutting power

Parameter	Values					
Type of wood cellular material	LSB			Dendrolight®		
Thickness of lamellae of the core layer (after surface's planing), mm	18	28	33	18	28	33
Height of grooves (kerfs) H, mm	7.455^{A}	12.636^{A}	15.136^{A}	13.700^{B}	23.700^{B}	28.700^{B}
Number of grooves z_{Σ}	11	11	11	11	11	11
Feed per tooth u_z, mm	1.613	0.779	0.528	0.563	0.185	0.135
Chip thickness h_{sk}, mm	0.357	0.224	0.166	0.168	0.072	0.057
Cutting force P, N	385	450	450	450	450	450
Cutting power G, kW	26.9	31.5	31.5	31.5	31.5	31.5
Ratio between the cutting power and the permissible feed speed ξ, kW m^{-1} min	0.163	0.378	0.558	0.523	1.592	2.186

^{A} – *equal to an average height of grooves (kerfs) (H_m; equation 13).*
^{B} – *equivalent height of kerf which is equal to the residual between thickness of lamellae of the core layer (after surface's planing) and 4.3 mm (thickness of the bottom wall of a wood cell).*

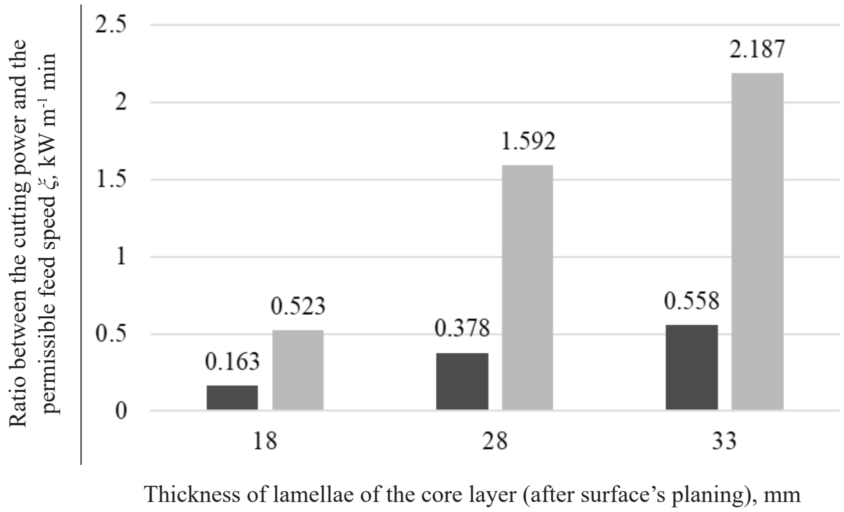


Figure 2. Ratio between the cutting power and the permissible feed speed:
■ – *in LSB lamella grooving;* ■ – *in Dendrolight® lamella grooving.*

$$\xi = \frac{G}{u}, \quad (15)$$

where: ξ is the ratio between the cutting power and the permissible feed speed, kW m^{-1} min;
G is the cutting power, kW. u is the feed speed, m min^{-1}.

Based on the results of Table 5 and Figure 2, the ratio between the cutting power and the permissible feed speed in LSB lamella grooving is 3.1 to 4.2 times lower when compared with the corresponding indicators in Dendrolight® lamella grooving. This proves that the grooving of LSB lamellae requires 3.1 to 4.2 times less power consumption. Although the actual cutting power consumption values are mostly the same, the same cutting power is achieved with a relatively higher feed rate in LSB production. In addition, the recommended value range of feed per tooth for the saw blades under production conditions is 0 to 1 mm (Nordström & Bergström, 2001), most appropriately including exactly the interval 0.528 to 1.613 mm, which corresponds to LSB.

Conclusions

The LSB design is very similar to Dendrolight®, but with changes in the grooves, the expected consumed cutting power is 3.1 to 4.2 times lower in the production of LSB compared with the cutting power required in the production process of Dendrolight®.

For additional energy savings, the permissible feed speed for grooving of LSB lamellae has not decreased, but has increased by 2.8 to 4.2 times compared with the permissible feed speed for the Dendrolight® manufacturing process.

As the cutting circumference diameter of the saw blade increases, the consumed cutting power decreases, while simultaneously the possible feed speed increases.

It is recommended to perform LSB lamella grooving not with a single four-sided processing machine, but with several machines placed one after the other in order to reduce the number of cuts to be made simultaneously and the depth of grooves (kerf) and to increase the permissible feed speed to the desired one, as the permissible feed speed is limited to 61 m min^{-1}.

The results of the theoretical calculations, obtained in the study, need to be further tested in practice, verifying their compliance and making corrections if necessary.

References

Ābele, A. (2017) *Apses (Populus tremula L.) koksnes garenzāģēšanas zāģripu griežņu nodilums un tā prognozēšana* (*Aspen (Populus Tremula L.) Wood Longitudinal Sawing, Ripsaw Blade Carbide Tip Bluntness and its Prediction*). Unpublished doctoral dissertation, Latvia University of Life Sciences and Technologies, Jelgava, Latvia (in Latvian; Summary in Latvian and English)

Barcík, Š., Pivolusková, E., & Kminiak, R. (2008) Effect of technological parameters and wood properties on cutting power in plane milling of juvenile poplar wood. *Drvna Industrija*, 59(3), 107-112.

Berger, G., Barbu, M.C., Huber, H., Berger, J., & Schwarzmann, G. (2016) Applying biomimicry in lightweight wood panel development. *World conference on timber engineering 2016*. Retrieved November 27, 2025, from https://repositum.tuwien.at/handle/20.500.12708/172

Elloumi, I., Hernández, R.E., Cáceres, C.B., & Blais, C. (2023) Effects of log temperature, moisture content, and cutting width on energy requirements for processing logs by a chipper–canter. *Wood Material Science and Engineering*, 18(2), 394–401. DOI: 10.1080/17480272.2022.2037705.

Fekiač, J., Svoreň, J., Gáborík, J., & Němec, M. (2022) Reducing the Energy Consumption of Circular Saws in the Cutting Process of Plywood. *Coatings*, 12(1). DOI: 10.3390/coatings12010055.

Freud (n.d.). *Circular saw blades for solid wood*. Retrieved September 29, 2025, from https://www.freudtools.com/worldwide/en/products/circular-saw-blades/stationary-machine/solid-wood/lm04.html

Iejavs, J. (2025) *Properties and the possibilities for improvement of pine (Pinus sylvestris L.) cellular wood material performance*. *Ph.D.* thesis, Latvia University of Life Sciences and Technologies, Jelgava, Latvia152 p.

Iejavs, J., & Spulle, U. (2016) Cellular wood material properties – rewiev. *Drewno–Wood*. Poznan: Institut Technologii Drewno, Vol. 59, No. 198, p. 5–18.

Ispas, M., Răcăşan, S., Bedelean, B., & Angelescu, A-M. (2025) Integration of ANN and RSM to Optimize the Sawing Process of Wood by Circular Saw Blades. *Applied Sciences (Switzerland)*, 15(18). DOI: 10.3390/app151810206.

Ivanovskiy, V. (2021) Improving the quality of the band saw cut. *IOP Conference Series: Earth and Environmental Science*, 875(1). DOI: 10.1088/1755-1315/875/1/012067.

Jin, Q., Jin, Y., Dong, H., Wu, Z., Zhang, F., Wang, J., … Guo, X. (2025) Machining performance of thermally modified wood in milling processes. *Materialwissenschaft und Werkstofftechnik*, 56(3), 339–352. DOI: 10.1002/mawe.202300339.

Koleda, P., Barcík, Š., & Nociarová, A. (2019) Effect of technological parameters of machining on energy efficiency in face milling of heat-treated Oak Wood. *BioResources*, 13(3), 6133–6146. DOI: 10.15376/biores.13.3.6133-6146.

Koleda, P., Čuchor, T., Koleda, P., & Rajko, Ľ. (2024) Prediction Models for the Milling of Heat-Treated Beech Wood Based on the Consumption of Energy. *Applied Sciences (Switzerland)*, 14(20). DOI: 10.3390/app14209539.

Krilek, J., Čabalová, I., Výbohová, E., Mamoňová, M., Ťavodová, M., Melicherčík, J., … Giudice, V.L. (2024) Assessment of the chipping process of beech (Fagus sylvatica L.) wood: knives wear, chemical and microscopic analysis of wood. *Wood Material Science and Engineering*, 19(2), 473–484. DOI: 10.1080/17480272.2023.2259343

Labans, E., & Kalnins, K. (2012) Numerical Modelling and Experimental Validation of Dendrolight Cellular Wood Material. *Proceedings of the 8th Meeting "Northern European Network for Wood Science and Engineering (WSE)"*. Lithuania, Kaunas, p. 177-184.

Labans, E., Kalnins, K., & Bikovs, A. (2012) *Simulation of Mechanical and Thermal*

Properties for Sandwich Panels with Cellular Wood Cores [tiešsaiste]. Scotland. Retrieved November 27, 2025, from http://webapp.tudelft.nl/proceedings/ect2012/pdf/labans.pdf

Leadermac (n.d.). Our Products. Retrieved September 29, 2025, from https://www.leadermac.com/index.html

Leitz (n.d.). Circular sawblades / *Processing solid wood length*. Retrieved September 29, 2025, from https://lexicon.leitz.org/en/product-categories/circular-sawblades/processing-solid-wood-length.html

Leuco (n.d.). *Gang-Rip Saw Blades*. Retrieved September 29, 2025, from https://www.leuco.com/EN/US/Circular_Saw_Blades/Gang-Rip_Saw_Blades#?marketing1=1000113123&B31=3%2C2&typ=artikel&marketing2=1000113124

Li, S., Wang, C., Zheng, L., Wang, Y., Xu, X., & Ding, F. (2016) Dynamic stability of cemented carbide circular saw blades for woodcutting. *Journal of Materials Processing Technology*, 238, 108-123. DOI: 10.1016/j.jmatprotec.2016.07.018.

Marthy, M., & Cismaru I. (2009) Experimental study concerning the power consumption at the milling of pear wood. *Pro Ligno*, 5(3), 47-52.

Merhar, M., Bjelić, A., & Hodžić, A. (2024) Modelling of Peripheral Wood Milling Power Using Design of Experiment Approach. *Drvna Industrija*, 75(4), 395–404. DOI: 10.5552/drvind.2024.0173.

Nasir, V., & Cool, J. (2019) Optimal power consumption and surface quality in the circular sawing process of Douglas-fir wood. *European Journal of Wood and Wood Products*, 77(4), 609-617. DOI: 10.1007/s00107-019-01412-z.

Nasir, V., Mohammadpanah, A., & Cool, J. (2020) The effect of rotation speed on the power consumption and cutting accuracy of guided circular saw: Experimental measurement and analysis of saw critical and flutter speeds. *Wood Material Science and Engineering*, 15(3), 140-146. DOI: 10.1080/17480272.2018.1508167.

Nordström, J., & Bergström, J. (2001) Wear testing of saw teeth in timber cutting. *Wear*, 250-2151(1-12), 19-27. DOI: 10.1016/S0043-1648(01)00625-1.

Pinkowski, G., Piernik, M., Wołpiuk, M., & Krauss, A (2024) Effect of Chip Thickness and Tool Wear on Surface Roughness and Cutting Power during Up-Milling Wood of Different Density. *BioResources*, 19(4), 9234-9248. DOI: 10.15376/BIORES.19.4.9234-9248.

Roziņš, R., Brencis, R., Spulle, U., & Spulle-Meiere, I. (2023). Sound Absorption Properties of the Patented Wood, Lightweight Stabilised Blockboard. Rural Sustainability Research, 50(345), 59–66. DOI: 10.2478/plua-2023-0015.

Roziņš, R., Vašuks, M., & Vašuks P. (2014a). Latvian Patent No. 14927A. Riga: Patent Office.

Roziņš, R., Vašuks, M., & Vašuks P. (2014b). Latvian Patent No. 14929A. Riga: Patent Office.

Tiryaki, S., Malkocoğlu, A., & Ozşahin, Ş. (2016) Artificial neural network modeling to predict optimum power consumption in wood machining. *Instytut Technologii Drewna*, 59(196), 109–125. DOI: 10.12841/wood.1644-3985.140.08.

Tuherm, H., & Ābele, A. (2014) *Koksnes griešanas procesi* (*Wood cutting processes*). Jelgava: Latvijas Lauksaimniecības universitāte, Meža fakultāte. Studentu biedrība „Šalkone”. 90 lpp. (in Latvian)

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