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PROCESSING SAWLOGS INTO PARQUET BLANKS

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ABSTRACT

The term parquet refers to a floor covering made of solid wood, consisting of interconnected slats in a horizontal plane. A parquet strip is the principal constructional element of the parquet. This wooden strip is obtained as a result of processing the flooring blank. In the sawmill processing of the sawlogs, the flooring blanks are sawn from the sawlogs, mostly in the radial and tangential direction. For such a purpose, sawlogs from domestic species and foreign species are used. Most dominant in this manner are the hardwood species, although softwood species can be used too. Among the domestic species, the most are beech, oak, acacia, elm, ash, and from the softwood species pine and larch.

The paper focuses on the maximum quantitative yield of beech and oak sawlogs intended for processing into parquet blanks. The sawing was conducted on a bandsaw. The blanks were with a thickness of 25,0 mm. The sawlogs belonged to the I, II, and III quality classes. A total of 12 sawlogs were processed, 6 from beech (*Fagus sylvatica* L.) and 6 from oak (*Quercus robur*). All sawlogs were with a constant length of 3,0 m. The mean diameter for beech and oak sawlogs was in the range of 34,0 to 36,0 cm.

The average value for the quantitative yield for beech sawlogs from I, II, and III quality classes was 37,90%. For the oak sawlogs from I, II, and III quality classes the average value of the quantitative yield was 39,40%.

Key words: beech, oak, sawlogs, maximum quantitative yield, quality class, parquet blanks.

INTRODUCTION

The primary source of raw materials for processing in the wood industry sector are the forest resources, which are an important branch for the economic life of the human population. Trees in forests grow and develop in close association with other plant species and the entire animal world, forming a complex plant-animal system called the forest biocenosis. As a complex system, the biocenosis affects the soil and climatic factors of the forest-covered parts of the Earth's surface. Of interest for primary wood processing are commercial and private forests, and the their managing methods. These forests are sources of forest assortments, all with the aim of obtaining the highest quality sawmill products after sawing and processing the raw materials, i.e. the sawlogs. Sawmill technology for wood processing, as a scientific discipline, deals with the technological processes of sawing logs and producing sawn assortments (sawn lumber). Primary machines are used for sawing logs, and the obtained products (boards, planks, parquet blanks, wooden elements, beams, etc.) are dimensioned with secondary machines.

Parquet blanks are wooden elements with parallel-edged sides and ends. They are intended for the production of parquet lamelas (strips). Parquet blanks are sawmill products used as raw material for the production of parquet. The wood species from which parquet blanks are made belong to the group of hardwoods such as beech, oak, locust, hornbeam, elm, ash, walnut, etc.

Beech parquet blanks, during their production, include parts of the sapwood, with small and healthy parts from the heartwood. They can be undergo hydrothermal treatment or can be left untreated. Oak, ash, elm, and walnut parquet strips are also intended for standard or solid wood parquet. They are made from the heartwood zone, without sapwood (Rabadziski 2019). Parquet blanks are sawn assortments with uniform thickness, without defects, with parallel-made edges. Their thickness ranges from 18.0 to 28.0 mm, width from 30.0 to 80.0 mm, and length from 200.0 to 700.0 mm. The technology for producing parquet blanks is not standalone, but is most often part of the sawmill processing of logs in the sawmill facilities. The production of parquet blanks is organized depending on the raw material used for that purpose. Thus, the blanks can be made from logs, technical wood of small dimensions, as well as from the quality part of the coars waste from the sawlogs. There are no special logs intended for parquet blanks.

According to Donchev *et al*. (1995), when using beech logs of III quality class, a low percentage of quantitative yield is obtained, ranging from 32.0% to 36.0%. The percentage of quantitative yield when processing I quality class oak logs ranges from 41.0% to 44.0%, and for II quality class from 37.0% to 42.0%. The reason for the low quantitative yield is the small dimensions of the blanks (thickness, width, and length), resulting in a significant portion of the wood volume being lost as fine and coarse waste. Furthermore, the processing of the blanks into parquet lamelas leads to additional loss of wood volume.

Smajić *et al.* (2023) researched the influence of wood defects and dimensions in oak parquet blanks on the parquet lamelas. A higher quantitative yield percentage was achieved with shorter and narrower elements, with the reasons for the higher yield percentage being that shorter blanks deform less during the drying process and have fewer defects compared to longer blanks. For longer blanks, it is not possible to produce a higher percentage of long clean parquet lamelas, while with shorter blanks it is possible to obtain a larger quantity of higher-quality shorter parquet lamelas.

High-quality boards or planks should not be used for producing parquet blanks. Thus, blanks will most often be made from waste, therefore utilizing the quality zones of the wood volume. The primary reason to avoid sawing logs into boards to produce parquet blanks is the low percentage of maximum qualitative yield. Due to the small dimensions of the parquet blanks, a large portion of the wood volume is lost in the form of fine waste, small chips, and coarse waste. Regarding dimensions, the allowed deviation in length of the blanks is ± 5.0 mm, and in thickness and width ± 1.0 mm. The moisture content of beech blanks after steaming and thermal drying should be between 8.0 and 10.0%.

This study attempted to investigate the maximum quantitative yield for beech and oak logs, sawn on a band saw into 25.0 mm thick boards, from which the processing technology produces blanks for normal (solid wood) parquet. Parquet blanks are raw material for the production of parquet lamelas used for making floor coverings. Parquet blanks can be obtained from sawing logs into boards and from the wooden waste intended for further processing.

MATERIAL AND METHODS

The materials used for the purpose of this research are sawlogs from beech (*Fagus sylvatica* L.) and oak (*Quercus robur*). The beech and oak sawlogs have a mean diameter ranging from 34.0 to 36.0 cm and a length of 3.0 m. They are graded as I, II, and III quality class logs. The logs were graded according to the Macedonian standard MKC EN 1313-2:2010 Round and sawn

timber – Permitted deviations and preferred sizes – Part 2: Hardwood sawn timber and MKC EN 1316-1:2013 Hardwood round timber – Qualitative classification – Part 1: Oak and beech. In this research, the blanks for the production of standard parquet lamelas are with dimensions of 25x50x450 mm and are made from beech and oak (Fig. 1).

Figure 1: Beech parquet blanks

The following mathematical formulas were used for the purpose of calculations:
a) sawlogs volume:

$$V = \frac{d_m{}^2 \cdot \pi}{4} \cdot l \, [m^3] \quad (1)$$

d_m – mean log diameter [cm]
π – = 3,14
l – log length [m]
b) quantitative yield:

$$P = \frac{V}{V_0} \cdot 100 \, [\%] \quad (2)$$

V – parquet blanks volume [m^3]
V_0 – log volume [m^3]

в) fine waste volume:

$$O_1 = n \cdot \sum h_c \cdot l_c \, [m^3] \quad (3)$$

n – number of cuts
Σ_{hc} – cut height [m]
l_c – cut lenght [m]

c) coarse waste volume:

$$O_2 = V_0 - (V_1 + O_1) \, [m^3] \quad (4)$$

V_0 – log volume [m^3]
V_1 – parquet blanks volume [m^3]
O_1 – fine waste volume [m^3]

BEECH AND OAK PROCESSING TECHNOLOGY FOR PRODUCTION OF PARQUET BLANKS

The technology of processing logs into parquet blanks is based on the single-phase technology, shown in Fig. 2.

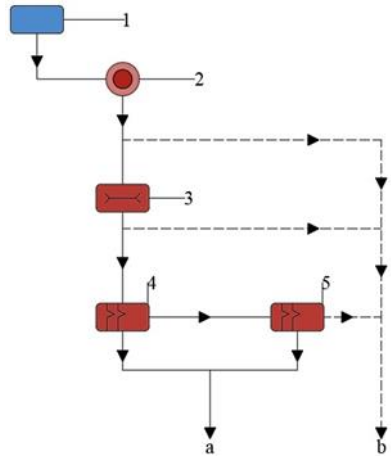

Figure 2: Single-phase logs processing,
1) logs warehouse, 2) main bandsaw, 3) transversal circular saw, 4 и 5) small bandsaw,
a) parquet blanks, b) coarse waste

The logs from the log warehouse (1) are delivered and sawn into boards on the main bandsaw (2). On the transversal circular saw (3) the sawn lumber defects are cut out and the length of the blanks are formed. The width of the blanks is obtained after sawing with the the small bandsaw (4 and 5). Then (a) indicates the finished product or parquet blanks, and then (b) the amount of coarse waste. The blanks have dimensions of 25x50x450 mm. Fig. 3 shows the sawing method used for the beech and oak logs. By this sawing method, planks with a thickness of 25.0 mm are obtained. The cut width of the main bandsaw machine is 1.5 mm. The cut width the transversal circular saw is 5.0 mm, and of the small bandsaw is 1.5 mm.

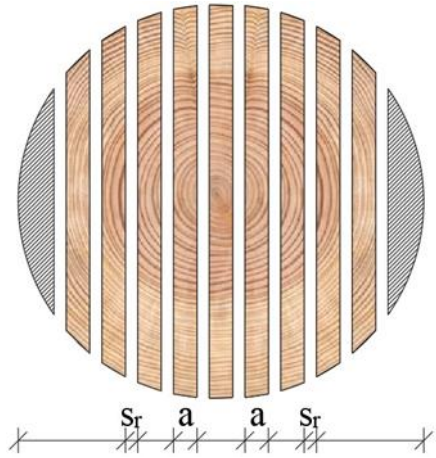

Figure 3: Live uneven sawing method ($\frac{9}{26}$) used for the beech and oak sawlogs

RESULTS AND DISCUSSION

An overview of the characteristics of the beech and oak logs, as part of this research, are shown in Table 1 (for the beech sawlogs) and in Table 2 (for the oak sawlogs).

Table 1: Analyzed beech sawlogs (*Fagus sylvatica* L.)

Count nr.	Mean diameter	Quality class	Lenght	Volume	Total volume
	d_m [cm]	K	l [m]	V [m^3]	V_o [m^3]
1	36,0	I	3,0	0,305	0,577
	34,0	I	3,0	0,272	
2	35,0	II	3,0	0,288	0,576
	35,0	II	3,0	0,288	
3	34,0	III	3,0	0,272	0,544
	34,0	III	3,0	0,272	

According to the data from Table 1, it can be concluded that the beech logs had a mean diameter of 34.0 to 36.0 cm, a length of 3.0 m, and that were graded as I, II and III quality class. In each quality class there were 2 processed logs, a total of 6, whose wood volume ranged from 0.544 to 0.577 m^3. The total wood volume was 1.7 m^3.

Table 2: Analyzed beech sawlogs (*Quercus robur*)

Count nr.	Mean diameter	Quality class	Lenght	Volume	Total volume
	d_m [cm]	K	l [m]	V [m^3]	V_o [m^3]
1	36,0	I	3,0	0,305	0,610
	36,0	I	3,0	0,305	
2	35,0	II	3,0	0,288	0,560
	34,0	II	3,0	0,272	
3	34,0	III	3,0	0,272	0,544
	34,0	III	3,0	0,272	

In Table 2, an overview of the oak logs is presented. They had a length of 3.0 m and an average diameter of 34.0 to 36.0 cm. The volume ranged from 0.544 to 0.610 m^3. A total of 6 logs were analyzed, two from each quality class, with a total wood volume of 1.72 m^3. The beech and oak logs had an initial moisture content of 58.0%. Based on the applied technology of log sawing with a bandsaw into 25.0 mm thick boards, and secondary processing of the boards into parquet blanks with a transversal circular saw and small bandsaw, the results for the quantitative yield of beech and oak logs are presented in Tables 3 and 4.

From Table 3, it can be observed that the volume of the blanks ranged from 0.087 to 0.130 m^3, and the quantitative yield from 32.0 to 48.38%. The volume of fine waste ranged from 0.01614 to 0.076 m^3, with an absolute value from 22.57 to 26.58%. The coarse waste for logs from the I to the III quality class increased, with its volume ranging from 0.0859 to 0.1206 m^3, or from 31.56 to 44.31%. The total waste volume was from 0.1582 m^3 to 0.1850 m^3, ranging from 57.62 to 68.0%.

The analysis of the results for the quantitative yield of oak logs, whose values are presented in Table 4, behaved similarly. It can be concluded that the volume of the blanks ranged from 0.0911 to 0.1361 m^3, and the quantitative yield was in the range from 33.49 to 44.62%. The fine waste was within the range of 0.0768 to 0.0840 m^3, or from 26.12 to 32.0%. The volume of coarse waste was from 0.0863 to 0.0953 m^3, or from 28.30 to 35.03%. The total waste ranged from 0.1632 m^3 to 0.1809 m^3, or from 55.38 to 66.51%.

Table 3: Quantitative yield of the beech sawlogs

Mark	Parquet blanks		Fine waste		Coarse waste		Total waste	
Sawlogs	$V\ [m^3]$	$P\ [\%]$	$O_1\ [m^3]$	$P_1\ [\%]$	$O_2\ [\%]$	$P_2\ [\%]$	$O_o\ [m^3]$	$P_o\ [\%]$
I q.class/1	0,130	42,38	0,0760	24,86	0,0990	32,76	0,1750	57,62
I q.class /2	0,1138	41,86	0,0723	26,58	0,0859	31,56	0,1582	58,14
II q.class /1	0,1101	38,25	0,0699	24,27	0,1080	37,48	0,1779	61,75
II q.class /2	0,1154	40,10	0,0717	24,90	0,1009	35,00	0,1726	59,9
III q.class /1	0,0870	32,00	0,0648	23,85	0,1202	44,15	0,1850	68,0
III q.class /2	0,0900	33,12	0,0614	22,57	0,1206	44,31	0,1820	66,88

Table 4: Quantitative yield of the oak sawlogs

Mark	Parquet blanks		Fine waste		Coarse waste		Total waste	
Sawlogs	$V\ [m^3]$	$P\ [\%]$	$O_1\ [m^3]$	$P_1\ [\%]$	$O_2\ [\%]$	$P_2\ [\%]$	$O_o\ [m^3]$	$P_o\ [\%]$
I q.class/1	0,1332	43,68	0,0797	26,12	0,0921	30,20	0,1718	56,32
I q.class /2	0,1361	44,62	0,0826	27,08	0,0863	28,30	0,1689	55,38
II q.class /1	0,1130	39,24	0,0840	29,15	0,0910	31,61	0,1750	60,76
II q.class /2	0,1088	40,02	0,0768	28,25	0,0864	31,73	0,1632	59,98
III q.class /1	0,0911	33,49	0,0856	31,48	0,0953	35,03	0,1809	66,51
III q.class /2	0,0958	35,22	0,0870	32,00	0,0892	32,78	0,1762	64,78

The average values for the quantitative yield of beech and oak logs are shown in Table 5. For better overview, a frequency polygon has been created to illustrate the relationship between the yield and quality class of beech and oak logs, as shown in Fig. 4.

Table 5: Average values for the quantitative yield of beech and oak logs, according to the quality class

Wood species	Quality class	Quantitative yield	Fine waste	Coarse waste
	K	$P_m\ [\%]$	$Q_{1m}\ [\%]$	$O_{2m}\ [\%]$
Beech	I	42,14	25,73	32,13
	II	39,18	24,58	36,24
	III	32,55	23,20	44,25
Oak	I	44,14	26,61	29,25
	II	39,62	27,21	33,17
	III	34,36	31,75	33,89

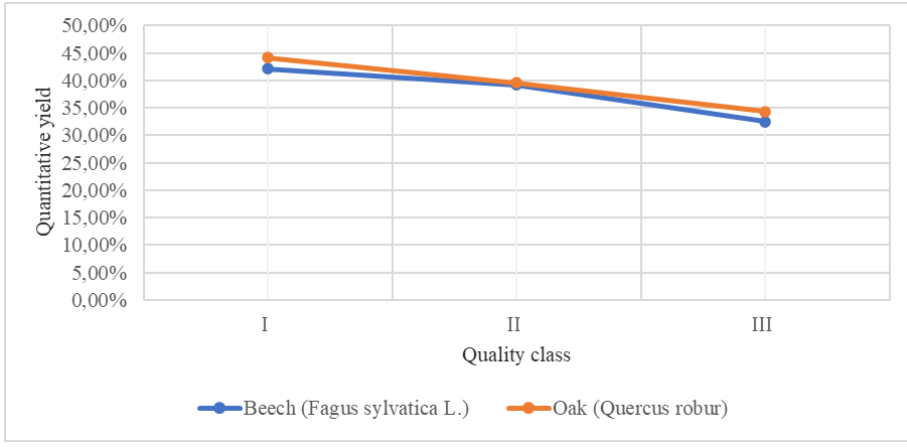

Figure 4. Relationship between the yield and quality class of beech and oak logs

The primary observation from the given is that from the I to the III quality class of logs for both wood species, the quantitative yield decreases, while fine and coarse waste increase. For

practical purposes, it is important to state how the quantitative yield of beech and oak logs graded as I, II and III quality class behaves. For this purpose, the results for the average values of the quantitative yield are shown in Table 6.

Table 6: Average values for the quantitative yield of beech and oak sawlogs

Wood species	Quality class	Quantitative yield	Fine waste	Coarse waste
	K	***P [%]***	***O_1 [%]***	***O_2 [%]***
Beech	I/III	37,90	24,50	37,60
Oak	I/III	39,40	28,50	32,10

Based on the data above, it can be concluded that the quantitative yield of beech logs graded as I quality class was to 42.14%, fine waste accounted for 25.73%, and coarse waste 32.13%; for II quality class the yield was 39.18%, fine waste 24.56% and coarse waste 36.24% and III quality class, quantitative yield 32.55%, fine waste 23.20% and coarse waste with a value of 44, 25%. For oak logs for the I quality class, the yield was 44.14%, fine waste 26.61%, coarse waste 29.25%; for the II quality class the quantitative yield was 39.62%, fine waste 27.21%, coarse waste 33.17% and for the III class, the quantitative yield was 34.36%, fine waste 31.75% and coarse waste 33, 89%. Also, the mean values for the logs graded as I/III quality class, for the quantitative yield for beech were 37.90%, fine waste 24.50% and coarse waste 37.60%. For oak logs, the quantitative yield was 39.40%, fine waste had a value of 28.50%, and coarse waste was 32.10%.

CONCLUSIONS

Parquet lamelas (strips) for floor covering (parquet) made of solid wood are produced from parquet blanks. The special logs intended for making parquet blanks do not exist. One of the most important reasons not to use logs from hardwood species (oak, beech, ash, etc.) for making parquet blanks is the small quantitative yield. Also, high-quality boards and planks should not be used for the production of the blanks. Most often, the blanks are made from high-quality coarse waste that is used for this purpose. Due to the small size of the blanks, as well as the large number of cuts, a large part of the wood volume of the logs is lost in fine waste, small chips, cutouts and cutoffs as coarse waste. It should be stated that the blanks suffer additional processing to produce lamelas with exact dimensions for parquet floorings, which leads to an additional loss of wood volume mostly in fine waste and small chips. It can be stated that the production of parquet blanks is not an independent production process, but is in accordance with the mechanical sawmill processing of the logs into sawn lumber, among which the blanks take their place, to increase the maximum quantitative yield.

Main conclusions:

1. Researched wood: beech and oak.
2. Dimensions of the beech and oak logs:
   - length, l = 3.0 [m];
   - mean diameter, d_m = 34.0 ÷ 36.0 [cm];
3. Log quality class: I, II and III class.
4. Qualitative yield of beech logs, I quality class, ranged from 41.86 to 42.38%, the average was 42.38%.

5. Quantitative yield of the II quality class beech logs ranged from 38.25 to 40.10%, the average was 39.18%.

6. Quantitative yield of the III quality class beech logs ranged from 32.00 to 33.12%, the average was 32.55%.

7. Quantitative yield of the I quality class oak logs was from 43.68 to 44.62%, the average was 44.14%.

8. Quantitative yield of II quality class oak logs was from 39.24 to 40.02%, the average was 39.62%.

9. Quantitative yield of III quality class oak logs ranged from 33.49 to 35.22%, average was 34.36%.

10. Mean values for quantitative yield:

- for beech logs, I/III quality class was 37.90%;
- for oak logs, I/III quality class was 39.40%.

11. The results for the fine waste volume had high values, shown in the paper.

12. The production of parquet blanks is not an independent production, but it is a part of the mechanical processing of sawlogs in sawn assortments, among which are parquet blanks.

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CONTENTS