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QUANTITATIVE EXPLOITATION OF WHITE PINE LOGS DURING EXPERIMENTAL AND SIMULATED SAWING

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ABSTRACT

Subject of this paper is analysis of max quantitative exploitation when treating experimentally (in practice) white pine logs and simulating treatment applying computer-supported programme. The major goal is, by means of experimental tests and simulation of treatment of the logs, to obtain information on max quantitative exploitation. Study objects were white pine logs. They were 4 m. long, with quality class I/П, with diameter ranging between 25,0 and 75,0 cm, distributed in V (five) thickness classes.

Technologically, the logs were first sawn on logs bandsaw, and the secondary treatment involved longitudinal and transversal sawing. The treatment applied was the so called “purposeful” sawing, which enabled obtaining specimens for construction purposes. Max quantitative exploitation from experimental tests ranges between 66,82% and 76,43%, the average value being 71,86%. When simulating the sawing process, the values were higher and ranged between 68,83% and 78,00%, the average value being 74,42%. For simulation of the treatment process, a programme entitled “simulation-SBG” was prepared.

Keywords: logs, white pine, class of quality, simulation, max quantitative exploitation

1. INTRODUCTION

Due to the fact that in the sawmills exact analyses based on experimental sawing or on applying programmes for computer simulation are not frequently applied, quite often unreliable data is used for quantitative exploitation. Based on these facts, this paper describes how experiments and simulation programme were used to study max quantitative exploitation when treating white pine logs, throughout all treatment stages.

2. WORKING METHOD

For realization of the goals set, we opted for the company ‘DRVO BOR”, where 80,00% of the total logs are white pine logs, 15,0 % are black pine and 5,0% are beech logs. With the purpose of providing for smooth running of the technological process, the sawmill was fitted with a logs bandsaw and machines for secondary treatment. Regarding the working methodology applied, in this paper we cover a few stages related to the raw material, sawing dispositions, applied methods for data processing and simulation of the programme. Depending on their mean diameter, the logs were distributed into the following classes: from 25,0 to 35,0 cm, from 35,1 to 45,0 cm, from 45,1 to 55,0 cm., from 55,1 to 65,0 cm. and from 65,1 to 75,0 cm.

In order to calculate the volume of the logs and the samples, the dimensions were taken applying mathematical formulas and methods from variation statistics.

When preparing the simulation programme referred to as “simulation-SBG”, we used input values, output values and invariable values.

3. RESEARCH RESULTS

Having applied the technological procedure and sawing dispositions, we will here provide the results of the experimental tests and simulation in sawing white pine logs. Firstly, we will present the data related to the raw material. It is given in Table 1.

Table 1. *Data regarding white pine logs*

Ord. No.	Thickness class (cm)	Number of samples (N)	Mark	Dimensions		Volume V (m^3)
				Average diameter dsr (cm)	Length L (m)	
1	2	3	4	5	6	7
1	25,0 ÷ 35,0	10	I	25,0	4,0	0,196
			II	33,0	4,0	0,342
			III	35,0	4,0	0,385
			IV	28,0	4,0	0,246
			V	30,0	4,0	0,283
			VI	32,0	4,0	0,322
			VII	34,0	4,0	0,363
			VIII	25,0	4,0	0,196
			IX	33,0	4,0	0,342
			X	31,0	4,0	0,302
2	35,1 ÷ 45,0	10	I	36,0	4,0	0,407
			II	37,0	4,0	0,430
			III	39,0	4,0	0,478
			IV	44,0	4,0	0,608
			V	43,0	4,0	0,581
			VI	36,0	4,0	0,407
			VII	42,0	4,0	0,554
			VIII	41,0	4,0	0,528
			IX	40,0	4,0	0,502
			X	36,0	4,0	0,407
3	45,1 ÷ 55,0	10	I	46,0	4,0	0,664
			II	48,0	4,0	0,723
			III	52,0	4,0	0,849
			IV	46,0	4,0	0,666
			V	46,0	4,0	0,664
			VI	53,0	4,0	0,882
			VII	50,0	4,0	0,785
			VIII	47,0	4,0	0,694
			IX	49,0	4,0	0,754
			X	54,0	4,0	0,916
4	55,1 ÷ 65,0	10	I	56,0	4,0	0,985
			II	58,0	4,0	1,056
			III	65,0	4,0	1,327
			IV	63,0	4,0	1,246
			V	60,0	4,0	1,130
			VI	57,0	4,0	1,020
			VII	56,0	4,0	0,985
			VIII	60,0	4,0	1,130
			IX	61,0	4,0	1,168
			X	58,0	4,0	1,056
5	65,1 ÷ 75,0	10	I	69,0	4,0	1,,494
			II	66,0	4,0	1,368
			III	67,0	4,0	1,409
			IV	66,0	4,0	1,368
			V	68,0	4,0	1,451
			VI	69,0	4,0	1,494
			VII	66,0	4,0	1,368
			VIII	70,0	4,0	1,540
			IX	71,0	4,0	1,610
			X	68,0	4,0	1,451
6	TOTAL	50				33,645 m^3

The table contains thicknesses of the classes, number of samples, their grade, mean diameter, length and volume of logs. The total quantity of logs was distributed into 5 (five) thickness classes. The logs belong to class I/Π quality, 4,0 m. long and with diameter ranging between 25,0 cm. to 75,0 cm. From each thickness class 10 samples were analyzed, which totals to 50 logs (column 3). The volume, depending on the diameter and length of the logs, varies from 0,196 m^3 and 1,610 m^3 In the same column (column 7) is put the total volume of the logs amounting 33,645 m. Products obtained from sawmill treated logs were planks, thick planks, beams, laths, fine waste (sawdust) and coarse waste (plywood pieces , cut-offs, cut-outs and lids).

In order to calculate the volume of the logs and the samples, the dimensions were taken applying mathematical formulas and methods from variation statistics. When preparing the simulation programme referred to as "simulation-SBG", we used input values, output values and invariable values.

The programme "simulation-SBG" was prepared to simulate sawing white pine logs, using so called sharp sawing, shaping prism and prism sawing. This is a way to reach quickly and simply data regarding quantitative exploitation, as well as the whole structure of exploitation (planks, thick planks, laths, sawdust, coarse waste). Let us point out that the cross section of the logs is considered an ideal circle. Figures 1 shows the sawing dispositions, as well as data concerning the specimens sawn, fine and coarse waste from treatment of white pine logs with diameter of 68,0 cm. (Table 2)

Structure of sawn wood and waste in pine log, diameter **dsr = 68cm**

Log volume: **V = 1,452 m^3**

Sawing dispositions: $\frac{R}{25}$; $\frac{R}{25}, \frac{1}{100}, \frac{R}{25}$; $\frac{4}{120}, \frac{R}{25}$

According to Log length: $\frac{4}{100} \Rightarrow l = 4{,}0\,m$; $\frac{20}{25} \Rightarrow l = 4{,}0\,m$; $\frac{3}{25} \Rightarrow l = 3{,}0\,m$

Max quantitative exploitation (1+2) **P = 76,86%**

Coarse Waste and Sawdust (3+4) **P = 23,14%**

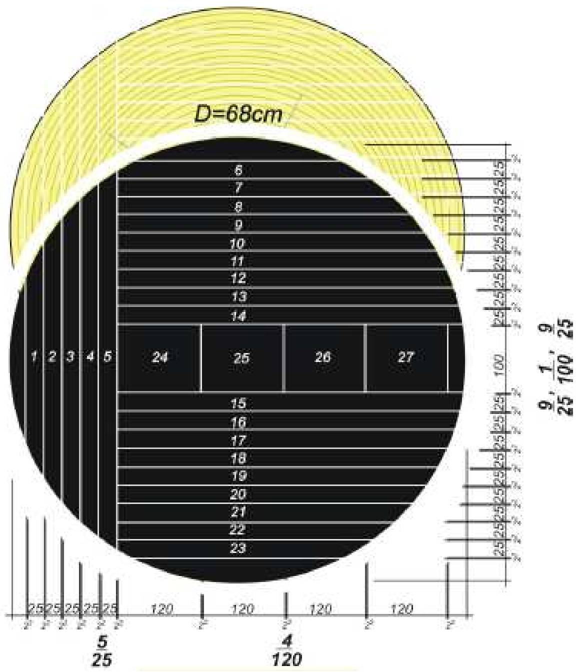

Figure 1. *Structure of sawn wood and waste in pine log, diameter 68,0 cm*

Table 2. *Structure of sawn wood, laths,sawdust and coarse waste, in pine log, diameter 68,0 cm*

Sawn wood (1)	**Mark**	**Thickness [m]**	**Width [m]**	**Length [m]**	**Volume [m^3]**
1	1	0,025	0,18	3,0	0,014
2	2	0,025	0,31	4,0	0,031
3	3	0,025	0,38	4,0	0,038
4	4	0,025	0,45	4,0	0,045
5	5	0,025	0,49	4,0	0,049
6	6	0,025	0,27	3,0	0,020
7	7	0,025	0,35	4,0	0,035
8	8	0,025	0,39	4,0	0,039
9	9	0,025	0,41	4,0	0,041
10	10	0,025	0,44	4,0	0,044
11	11	0,025	0,45	4,0	0,045
12	12	0,025	0,46	4,0	0,046
13	13	0,025	0,47	4,0	0,047
14	14	0,025	0,49	4,0	0,049
15	15	0,025	0,49	4,0	0,049
16	16	0,025	0,47	4,0	0,047
17	17	0,025	0,46	4,0	0,046
18	18	0,025	0,45	4,0	0,045
19	19	0,025	0,44	4,0	0,044
20	20	0,025	0,41	4,0	0,041
21	21	0,025	0,39	4,0	0,039
22	22	0,025	0,35	4,0	0,035
23	23	0,025	0,27	3,0	0,020
24	24	0,100	0,12	4,0	0,048
25	25	0,100	0,12	4,0	0,048
26	26	0100	0,12	4,0	0,048
27	27	0,100	0,12	4,0	0,048
				Total (1)	1,101 m^3
	PERCENT IN RELATION TO V:				75,83 %
Laths (2)	quantity	thickness [m]	width [m]	length [m]	volume [m^3]
	24	0,025	0,025	1,0	0,015 m^3
				TOTAL (2):	0,015 m^3
	PERCENT IN RELATION TO V:				75,83 %
Sawdust (3)		∑h of sawing [m]	l of sawing [m]	b of sawing [m]	Volume [m^3]
		8,352	4	0,0022	0,073 m^3
	PERCENT IN RELATION TO V:				5,06 %
Course Waste (4) = V – (1+2+3) =					0,262 m^3
	PERCENT IN RELATION TO V:				18,08 %

Our attention is primarily focused on the results on max quantitative exploitation and comparison of the data on experimental and simulated research.

In order to simplify the comparison of the results on using wood in an experimental way with the results obtained from the programme simulation-SBG", and to make them clear to see, they are shown in Table 3. The same table also gives the mean statistically calculated values of quantitative exploitation. Our conclusion was that with the programme “simulation-SBG” higher values for max quantitative exploitation were obtained, varying between 1,93%and 3,16%.

For better presentation and comparison of the quantitative exploitation regarding the thickness classes, the values obtained from practical testing and those from simulation of treatment are presented in Figure 2.

Table 3. *Quantitative exploitation, experimental / simulation-SBG*

Thickness class (cm)	Quantitative exploitation	
	Experimental (%)	simulation-SGB (%)
1	2	3
25,0-35,0	66,82 ± 1,11	68,83 ± 0,31
35,1-45,0	69,65 ± 0,99	72,81 ± 0,55
45,1-55,0	72,30 ± 1,03	75,40 ± 0,61
55,1-65,0	75,15 ± 1,37	77,08 ± 0,35
65,1-75,0	76,43 ± 1,46	78,00 ± 0,21

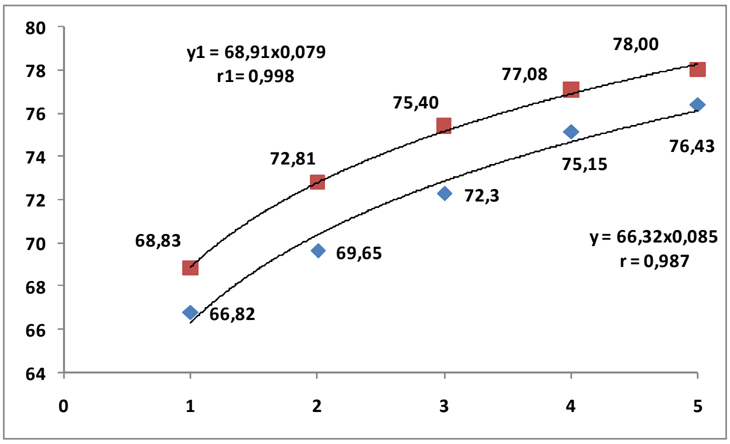

Figure 2. *Relation between quantitative exploitation and thickness classes, experimental / simulation-SBG*

The complexity of the research (experimental/simulation-SBG) is supported with the results on minimum, maximum and average values of quantitative exploitation, sawdust, coarse waste and total waste. These values are presented in Table 4.

Table 4. *Average values – quantitative exploitation, sawdust, coarse waste and total waste*

Research	Average values											
	Quantitative exploitation			Sawdust			Coarse waste			Total waste		
	x_{min}	x_{max}	x_{av}	x_{min}	x_{max}	x_{av}	x_{min}	x_{max}	x_{av}	x_{min}	x_{max}	x_{av}
1	2	3	4	5	6	7	8	9	10	11	12	13
Simul. SGB.	68,83	78,00	74,42	5,50	6,36	5,87	16,50	24,81	19,20	22,00	31,17	26,84
Experim.	66,82	76,43	71,86	8,93	11,30	10,18	12,27	23,97	18,19	23,57	33,18	28,36

With the programme “simulation-SBG”, the minimum quantitative exploitation value was 68,33%, the maximum one was 78,00% and the average one was 74,43%. As to experimental research, the values were slightly lower, being 66,82%, 76,43% and 71,86 for the minimum, maximum and average value respectively. The data on sawdust in simulation of process varied between 5,5% and 6,36%, the average value being 5,87%. With experimental research, the values ranged from 8,93% to 11,30%, the average value being 10,18%. The coarse waste (programme “simulation-SBG”) had a minimum value of 16,50%, maximum value of 24,81% and average value of 19,20%, thus having slightly higher values than the ones obtained in an experimental way, which ranged between 12,27% and 23,97%, the average value being 18,19%. The total quantity of waste was inversely proportional to the max quantitative exploitation.

4. CONCLUSIONS

The results in this paper are primarily concerned with max quantitative exploitation. The analysis also includes the quantity of fine, coarse and total waste.

Identified conclusions:

1. Raw material to be tested, white pine logs. Quality class I/Π. Length of 4,0 m. Diameter of 25,0 cm to 75,0 cm. The test covered 50 logs with total wood volume of 33,65 m^3.
2. Diameter of log 68,0 cm
   -max quantitative exploitation of 76,86%
   -coarse waste and sawdust of 23,14%
3. Experimental (practical) tests
   - quantitative exploitation, within the limits of 66,82% to 76,43%. Average value 71,86%.
   - sawdust, from 8,93%, average value 10,18%, to 11,30%.
   - coarse waste, from 12,27%, average value 18,19%, to 23,98%.
   - total waste, from 23,57%, average value 28,36%, to 33,18%.
4. Programme “simulation SBG”
   - quantitative exploitation, minimum 68,83%, maximum 78,00%, average value 74,42%.
   - sawdust, from 5,50%, average 5,85%, to 6,36%.
   - coarse waste, from 16,50%, average 19,20, to 24,81%.
   - total waste, from 22,00%, average 26,84, to 31,17%.

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