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Quality and Dimensional Parameters of Large-Sized Pine Timber in View of Expectations of Polish Sawmill Industry

Kvaliteta i dimenzijski parametri borove građe velikih dimenzija u svjetlu zahtjeva poljske pilanske industrije

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ABSTRACT • *Changes in the processing directions of round wood require the selection of raw material with appropriate quality and dimensional characteristics. In the case of large-size pine wood, these parameters translate significantly into its value and material indicators. The purpose of the research was to verify the currently applied classification principles with respect to the expectations of the market of wood industry customers. The research was conducted using the direct survey method, taking into account the structure of processing and sorting of production of wood industry representatives. The basic dimensional and quality groups for coniferous wood were separated, with wood defects assigned to them, in accordance with the currently binding principles of the quality and dimensional classification conducted by the State Forests. The respondents pointed out the necessity of changes in the minimum dimensions for wood of higher quality classes and changes in admissibility of selected defects in wood of lower classes.*

KEYWORDS: *scots pine; large-size wood; classification; wood defects; market preferences*

SAŽETAK • *Promjene u načinu obrade trupaca zahtijevaju odabir sirovine odgovarajuće kvalitete i dimenzija. Kad je riječ o borovoj građi velikih dimenzija, ti parametri znatno utječu na njezinu vrijednost i materijalne pokazatelje. Cilj istraživanja bio je provjeriti trenutačno primjenjive pravilnike o klasifikaciji borove građe s obzirom na očekivanja tržišta drvne industrije. Istraživanje je provedeno metodom izravnoga anketnog ispitivanja predstavnika drvne industrije, pri čemu su uzeti u obzir struktura obrade proizvoda i način proizvodnje. Crnogorično je drvo razvrstano u osnovne dimenzijske i kvalitativne skupine kojima su pridodane greške drva, sukladno trenutačno obvezujućim pravilnicima o klasifikaciji drva prema kvaliteti i dimenzijama što ih provode Državne šume. Ispitanici su upozorili na nužnost promjene minimalnih dimenzija za drvo višeg razreda kvalitete te promjene glede dopuštenih grešaka drva nižeg razreda kvalitete.*

KLJUČNE RIJEČI: *borovina; drvo velikih dimenzija; klasifikacija; greške drva; očekivanja tržišta*

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1 INTRODUCTION

1. UVOD

The development of the sawmilling sector is dependent on raw material resources. It is determined by the availability of timber which would ensure the execution of production orders. At present, shortages of timber negatively influence the wood industry both in Poland and worldwide. Despite the considerable increase in timber prices, wood products continue to be in high demand. Although its resources are limited, the great demand for timber on the global market results, among other things, from the environmental directives reducing the carbon footprint, as well as an increased interest in renewable energy sources. Additionally, price fluctuations destabilise the world timber market, influencing the situation of both wood conversion enterprises and manufacturers of wood-based products.

Factors directly influencing production costs include technological and material efficiency. They are crucial for the production profitability in economic entities operating in the wood sectors (Salehirad and Sowlati, 2006; Neykov *et al.*, 2020). Both their measurement and improvement are essential for the development and progress in any enterprise (Kovalčík, 2018). Production efficiency is influenced by the current ratio of the product price to the price of the raw material. Thus, each growth in raw material prices, while maintaining product prices at the same level, will result in the reduction of production profitability. In sawmilling conversion processes, the quality of timber and its customisation are major parameters affecting their efficiency (Dzbeński *et al.*, 2007; Wieruszewski and Mydlarz, 2021).

The production of round materials is based on standards; they define the principles of sorting and the principles of separation and characteristics of individual grades. When separating timber for production, standards are applied, which should not limit the possibility of their flexible separation, especially by agreement of the parties involved in the commodity trade. In this respect, characteristic is exemplified by, among others, the sawmill production. The rules of sorting raw material adopted in the country provide for differentiation in quality both in domestic and foreign trade.

Market research is a popular method of obtaining empirical data on market needs. Surveys are commonly applied, particularly in marketing research and market analysis (Nowicki, 1993; Ratajczak, 2001, 2003). Opinions of timber buyers are elements of studies on the effect of raw material quality on directions of its application, in line with sustainable development trends both at the level of the wood industry and forest management operations (Marianowska, 2005; Gonzalez *et al.*, 2019). Market research makes it possible to

identify demand preferences, which characterise investigated groups of processors with specific technological processes (Bell *et al.*, 2013; Dammer *et al.*, 2016; Daian and Ozarska, 2009). This research consists in the analysis of the target group, limited in terms of their interest and the number of respondents. An advantage of surveys is connected with the fact that they provide research results within a short period of time. However, a drawback of this method, when applied to determine market needs, may result from the low share of data returned by respondents, which is reflected in the lesser accuracy of analyses due to limited representativeness of obtained data. This paper refers to assortment grading of softwood timber on the wood market in Poland. Grading was based on quality requirements for roundwood defined as the Technical Specifications for large-sized softwood timber (Regulation no. 51, Malinowski and Wieruszewski, 2017). The authors applied the survey method to assess the assortment grading of pine timber based on feedback from representative wood conversion operators in Poland.

The aim of the study was to indicate the direction of expected changes in national standardisation adapted to the requirements of coniferous roundwood sorting for sawmill processing.

2 MATERIALS AND METHODS

2. MATERIJALI I METODE

The objective of this study was to verify the characteristics of timber specific to softwood and affecting its utilisation, depending on the specific operations of sawmills. The research theses were grouped based on the main thematic sets concerning dimensions and wood defects. The sawmilling market was investigated within the adopted methodology of direct questionnaire surveys (Collective work, 2010; Stupnicki, 2015). Respondents assessed the effect of quality and dimensional characteristics of softwood for sawn timber products described in the Technical Specifications. Presented ranges of wood characteristics are reflected in the principles of their classification. Based on the recorded and synthesised results individual quality factors were adapted to the currently binding classification of large-sized softwood timber. Such collected and systematised data made it possible to evaluate the expectations of the wood industry in relation to the current timber classification. The study was conducted on a set of data, which covered assessment of the principles of roundwood classification. Questions directed to representatives of sawmilling companies addressed principles specifying the criterion of wood quality. To maintain comparability of recorded results, it was assumed that quality elements identified by sawmills for timber (i.e. wood defects) were determined based on

Table 1 Features and layout of defects for large coniferous raw material included in the survey**Tablica 1.** Značajke i raspored grešaka crnogoričnog drva velikih dimenzija obuhvaćenih anketnim istraživanjem

Feature to be assessed (dimension or scope) <i>Značajka koja se procjenjuje (dimenzija ili opseg)</i>	Proposed quality class from the highest <i>Predložena klasa kvalitete poredana od najviše do najniže</i>
Min. diameter at thinner end, cm / <i>najmanji promjer na tanjem kraju</i> , cm	WA0, WB0, WC0, WD, other
Min. length, m / <i>najmanja duljina</i> , m	
Open knuckles, diameter in cm / <i>neurasle kvrge</i> , promjer, cm	
Tumors, height in cm / <i>tumori</i> , visina, cm	
Roses, diameter in cm / <i>sljepice</i> , promjer, cm	
Frontal/lateral cracks, range / <i>čeoone/radijalne pukotine</i> , raspon	
Curvature, cm/m / <i>zakrivljenost</i> , cm/m	
Twist of fibres, cm/m / <i>usukanost žice</i> , cm/m	
Rind gal, width in cm / <i>urasla kora</i> , širina, cm	
Blue and brown stain, range / <i>plavetnilo i smeđa obojenost</i> , raspon	
Resinosis, range / <i>lučenje smole</i> , raspon	
Internal or external rot, range / <i>unutarnja ili vanjska trulež</i> , raspon	
Insect walkways, depth in mm / <i>rupe od insekata</i> , dubina, mm	
Foreign bodies, YES/NO / <i>stana tijela</i> , DA/NE	
Other proposed features / <i>druge predložene značajke</i>	

WA0 – first class / *prva klasa*, WB0 – second class / *druga klasa*, WC0 – third class / *treća klasa*, WD – fourth class / *četvrta klasa*

the requirements of the PN-79/D-01011 standards. The numbers of quality and dimension grades were arbitrary. A preliminary identification was conducted for the effect of minimum diameter dimensions and length of timber, the share of major defects such as open knots, knobs, roses, end shakes and edge cracks, curvature, twisting, necrosis, blue stain, brown sap stain, resinosis, inner and surface rot, insect holes, foreign bodies as well as other proposed characteristics of roundwood on suitability for specific conversion types.

Analyses were conducted in the years 2017-2019. The number of questionnaires was selected so that it was equivalent to over 5 % of wood industry plants in Poland based on the data from 2016, when a total of 6084 customers were registered at the Forestry and Timber Portal (Malinowski, 2020). The questionnaires were addressed to 390 plants and 37 were returned (which accounted for 9 % of the total). Most frequently, the questionnaire respondents were entrepreneurs converting from 10 thousand m³ to 50 thousand m³ timber (33 % of respondents). The least numerous group among the returned questionnaires comprised representatives of the wood industry converting less than 500 m³ timber annually (3 % of all respondents).

This study lists grading principles (Technical Specifications - WT) and changes proposed by buyers representing the wood industry (Proposals - Pr). Only the proposals of changes in quality parameters indicated most frequently in the questionnaires were included (Table 1). This list does not include wood defects, in relation to which expectations of customers are consistent with the currently binding technical specifications.

3 RESULTS

3. REZULTATI

When verifying timber utilisation preferences of sawmills, it needs to be stressed that most respondents accepted the current quality classification system of 4 grades adopted for softwood timber. Only in three cases it was proposed to limit it to three quality classes. No changes in wood grading were proposed in any of the questionnaires, in terms of wood thickness, to the presently applied 3-class thickness classification.

Dimensional parameters indicated as requiring corrections concerned only two elements, i.e. the minimum length of large-sized softwood timber and minimum top diameter (Table 1). Dimensional groups are important in view of the references to these groups in the regulations concerning timber classification in the State Forests (Regulation no. 51 DGLP). The minimum length of timber is the shortest segment of large-sized timber meeting the current regulations related to quality and dimensional parameters during timber conversion. The minimum top diameter is the smallest diameter of the thinner log end measured to 1 mm inside bark. The minimum length of large-sized timber on the whole ranged from 2.7 m and 14 m. For quality grade 1 WA0, the lengths proposed by the representatives of the wood industry plants ranged from 2.7 m and 8 m. In individual classes, the following were the most frequently selected length ranges: WA0 – from 6.0 m (37 % of responses), WB0 – from 6.0 m (38 %), WC0 – from 3.0 m (26 %) and WD – from 2.7 m (27 %). The least frequently proposed top log diameter (i.e. the thinner end) was in the range of 12 cm - 30 cm, where in terms of individual grades the highest number of re-

Table 2 List of dimensional parameters according to technical conditions and surveys for large-size wood (Malinowski, 2020)**Tablica 2.** Popis dimenzijskih parametara prema tehničkim uvjetima i prikupljenim anketnim podacima za drvo velikih dimenzija (Malinowski, 2020.)

Dimensions / Dimenzije		Class of wood / Klasa drva			
		WA0	WB0	WC0	WD
Min upper diameter, cm / najmanji gornji promjer, cm	WT	22	14	14	14
	Pr	25	20		
Min length, m / najmanja duljina, m	WT	2.7	2.7	2.7	2.7
	Pr	6	6	3	

WT – technical conditions / tehnički uvjeti; Pr – proposal / prijedlog

sponses included the following grades: WA0 – 25 cm (50 % of responses), WB0 – 20 cm (33 %), WC0 – 14 cm (39 %) and WD – 14 cm (52 %). The presented percentage shares indicate a considerable percentage of responses for a given dimension.

In terms of timber quality, the respondents evaluated the weight of considered wood defects (Table 3). The importance of defects proposed for the classification of timber utilisation is almost identical to the currently binding classification. However, respondents

indicated an additional wood feature, i.e. resinosis, which should be included in the Polish classification of roundwood.

When comparing the currently binding classification principles and the most frequently presented proposals concerning the range of observed wood defects, it may be stated that their considerable share was analogous. One of the most important proposed changes suggested a rejection of the classification of higher quality grades (WA0 and WB0) based on the first four

Table 3 List of quality parameters according to defects (Malinowski, 2020)**Tablica 3.** Popis parametara kvalitete vezanih za greške (Malinowski, 2020.)

Knots / Kvrge		Class of wood / Klasa drva			
		WA0	WB0	WC0	WD
Open knuckles diameter, cm promjer neuraslih kvrga, cm	WT	N	N	D	D
	Pr			2	2
Tumors, height in cm tumori, visina, cm	WT	N	½ circuit	D	D
	Pr		N	1	
Roses, diameter in cm sljepice, promjer, cm	WT	D	D	D	D
	Pr	N	N	N	
Rot / trulež		WA0	WB0	WC0	WD
Internal decay, ø forehead unutarnja trulež, udjel u promjeru čela	WT	N	N	1/5 ø	1/3 ø
	Pr			N	N
External rot, perimeter on ø front vanjska trulež, udjel u opsegu na promjeru čela	WT	N	N	1/4 at 1/10	D
	Pr			N	N
Construction defects / konstrukcijske greške		WA0	WB0	WC0	WD
Rind gal, cm urasla kora, cm	WT	D	D	D	D
	Pr	N	N	N	
Resinosis, range lučenje smole, raspon	WT	D	D	D	D
	Pr	N	N	N	
Twist of fibers, cm/m usukanost vlaknaca, cm/m	WT	5/1	D	D	D
	Pr	N	N	N	
Stain / obojenje		WA0	WB0	WC0	WD
Blue stain plavetnilo	WT	N	N	1/2	D
	Pr			N	
Brown stain smeđa obojenost	WT	N	N	N	D
	Pr			N	
Cracks / pukotine		WA0	WB0	WC0	WD
Lateral and frontal/lateral cracks radijalne i čeone/radijalne pukotine	WT	N	N	N	D
	Pr				N
Mechanical damage / mehanička oštećenja		WA0	WB0	WC0	WD
Insect walkways rupe od insekata	WT	N	N	N	D
	Pr				N
Foreign bodies strana tijela	WT	N	N	N	D
	Pr				N

N – unacceptable / neprihvatljivo; D – acceptable / prihvatljivo

meters (this proposal concerns the share of open knots and knobs). According to the respondents, the Polish softwood grading system needs to meet the requirements, in which conditions for a given grade have to be met over the entire section of graded timber (while observing the specification for the shortest section). It should be stressed that in Polish forests large-sized softwood timber has been inspected by sections since 1967 and that the requirements of the PN-67/D-95017 standard apply.

4 DISCUSSION

4. RASPRAVA

The proposed high quality grades (WA0 and WB0) in the Polish softwood timber classification, characterised by increased quality requirements, may be associated with the growing market value of this raw material (Adamczyk, 2002; Adamowicz and Cierniak, 2011; Lis, 2012). Higher quality of large-sized softwood timber indicates the interest of enterprises in enhancing efficiency indexes for performed conversion operations (Ratajczak and Pikul-Bieniek, 2009). Highly accurate dimensioning of produced timber also aims at increasing the quality and improving rational utilisation of the raw material (Przypaśniak, 2015). The analysis of questionnaire survey studies indicates frequent responses confirming the indication of minimum length of higher quality timber (6.0 m), which includes a proposal for timber length standardisation. The marked discrepancy and at the same time the varied range of indicated wood defects for individual quality grades may indicate that the approach of the State Forests is still insufficiently adapted to the needs of their customers (Ratajczak, 2001, 2003). An example of the convergent regulations binding under the current conditions for classification and proposals of the respondents may be provided by the guidelines for the determination of curvature, discolouration and spotting, as well as mechanical damage. Globalisation is now a phenomenon that also affects wood-based industries. The timber trade and market are based on the theory of derived demand, which means that the demand for timber depends on the demand for final products (Paluš *et al.*, 2021). Work on changing wood sorting systems is also underway in other European countries. These activities are aimed at adapting and adjusting the assortment structure within the wood processing lines and the use of products (Brandstetter *et al.*, 2020; Burawska-Kupniewska *et al.*, 2021).

The additional specification of such a defect as resinosis and its relatively restrictive treatment may indicate a growing demand for sawn products, where this defect is particularly undesirable. Resinosis reduces the potential for surface refining and bonding of wood.

This results from the directions of extensive prefabrication of softwood timber. It is also a major drawback of the softwood timber classification in accordance with the European standards PN-EN 1611-1:2002/A1:2003 Sawn timber – Classification of softwood timber based on visual inspection – Part 1: European spruce, fir, pine, Douglas pine and larch.

By increasing the requirements and technical parameters for roundwood of higher quality classes and attempting to provide dimensional standardisation of timber will promote adaptation of the timber market to European standards PN-EN 1927-2: 2008.

5 CONCLUSIONS

5. ZAKLJUČAK

The sawmilling sector expects individual dimensional verification of minimum length (from 3 m in class WC0 and from 6m in higher classes) and thickness of softwood for higher quality classes (from 20 cm in class WB0 and 25 cm in class WA0), as well as grading of timber based on the inspection of timber sections of specific, comparable quality.

In the case of the quality classification concerning anatomical structure defects buyers mostly expect higher quality in lower quality grades (especially for knots, rind gal, resinosis, twist of fibres).

Defects related to discolouration or mechanical damage are consistent, to a considerable extent, with the currently binding technical specifications.

Defects, which to date have been disregarded in the classifications, play an increasingly important role and determine the utilisation of obtained sawn materials. Resinosis is an example of such defects.

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