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SPRUCE TIMBER QUALITY IN TREES WITH DIFFERENT THICKNESS FROM THE BESKIDY MTS

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Abstract. An advancing process of ageing of stands in Poland and Europe allows for predicting and increasing in the supply of large-dimension timber. The research compares selected qualitative characteristics of the timber of trees with large breast-height diameters (equal to or larger than 40 cm) with those of thinner trees on the example of Norway spruce from the region of the Beskidy Mts. A group of thicker spruce trees was characterized by a higher overall share of trees with wood defects, including visible knots and symptoms of overgrown knots as well as a smaller share of trees with injuries, rot and curvatures in comparison with the thinner ones. The absolute size of rot on the cross-section of the stem was larger in thicker trees. They were also characterized by a smaller average width of annual rings. The groups compared did not differ significantly as to the height of location of defects situated as first from the stem base.

Key words: spruce timber, thicker and thinner trees, timber defects

INTRODUCTION

Both in Poland, as well as in the whole of Europe, timber resources on the stem constantly increase, the process of ageing of stands develops and there are prospects of increasing the supply of large-dimension timber.

Poland's forestage currently amounts to 28.8% and by the year 2050, thanks to the implementation of the National Programme for Increasing Forestage, it is going to grow to 33%. Stands older than 80 years constitute 18.9% of Polish forest area and comprise 30.2% of its forest resources. In each age class (except KO and KDO stands), an increase in volume 1 ha has been noted for several decades and in the classes from III up (i.e. from 41 to 60 years old) – also an increase in the area. According to experts, this is the result of the necessity to carry out planned cleanings and thinnings, intensification of sanitation fellings and removal of damage caused by wind and snow as well as reduction of the area of clear fellings together with the simultaneous requirement to observe the yearly plan of timber harvesting [Kołodziejczyk and Zubkowicz 2006, Raport... 2006].

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The amount of timber harvested in Poland systematically increases and now amounts to over 32 mln m^3 (in 2005), which constitutes only half of the annual volume increment. In the oldest, overmature stands, there are already almost 190 mln m^3 of timber, which is over six times more than the average annual harvest [Kołodziejczyk and Zubkowicz 2006]. An increase in timber resources in overmature stands is accompanied by a threat of quality decrease and depreciation of the timber, which remains on the stem too long.

This more and more significant issue of the increasing supply of large-dimension timber of older age classes, its quality and usefulness for industrial purposes on the European scale, was taken up by a group of scientists within Action E40 COST. It is the authors' intention that the present study could aid better recognition of the quality of the timber under analysis. The aim of the present research is comparison of selected parameters and qualitative characteristics of timber from trees with different thickness on the example of Norway spruce (*Picea abies* L. Karst.).

MATERIAL AND METHODS

The study was based on the material collected in the years 2001-2004 within the project "Differentiation of utility value of timber in the forests of the Żywiecczyzna Region" [Barszcz 2004]. In the course of the research project, 70 sample plots were set up in the selected mountainous stands of the Beskid Śląski and Beskid Żywiecki Mts (southern Poland), which constitute an industrially significant base of spruce timber in Poland. During the selection of the stands, the important aspects considered were: altitude (from 580 to 1300 m), bedrock (three dominant types) and the character of forest management (natural stands, monocultures and rebuilt stands). The age of spruce in stands whose character was close to natural ranged from 74 to 257, in monocultures from 29 to 193, in older rebuilt stands from 50 to 83 and in younger rebuilt stands from 20 to 44. Spruce quality class in the examined stands was as follows: from I to IV,5 (natural stands), from I to V (monocultures), from I to III (older rebuilt stands) and from I to II (younger rebuilt stands). Volume per 1 ha of stands amounted from 100 to 730 m^3/ha in natural stands, from 70 to 886 m^3/ha in monocultures, from 35 to 509 m^3/ha in older rebuilt stands and from 15 to 100 m^3/ha in younger rebuilt stands. Density index of single stands ranged from 0.3 to 1.3 [Plany urządzenia... 2001-2003].

On each sample plot, 15 sample trees were selected by means of Draudt's method, separately for each dominant species. The present study considers only spruce timber, altogether 1050 trees.

The following features were measured on each sample tree: breast height diameter, tree height and height of crown base. Moreover, the tendency to change the technical quality of the stem was determined [Barszcz 1988], where:

– tendency 1 (increasing) characterizes trees with a predicted increasing technical quality of the stem during their further life (very good stem quality; biosocial site and crown vitality guarantee long life of the tree in the stand);
– tendency 2 (permanent) characterizes trees which do not reveal the process of change of the technical quality of their stems while these trees remain long in the

stand (average or low stem quality but biosocial site and crown vitality as in tendency 1);
- tendency 3 (decreasing) characterizes trees with a decreasing technical quality (stem quality as in tendency 2 but these trees are weakened or dying).

The next measure taken to examine, along the section of 4 m from the stem base was, the occurrence of timber defects significant for the classification of spruce timber quality according to the Polish standards [PN-79/D-01011]. The predicted height of the cut back was assumed to be the base of the stem, because the research was done on standing trees. For each first (from the stem base) occurrence of a given type of defect (except curvatures), the height of its location was noted.

Then 1 sample (core) was taken by means of Pressler's drill from each sample tree at its stem base. The direction of drilling varied; on the slopes the samples were taken at the lower side.

During computation, the trees were divided into two groups:

1) the ones with breast height diameter up to 40 cm
2) the ones with breast height diameter equal to or larger than 40 cm.

Data analyses were performed by means of comparing the parameters of the trees and the qualitative characteristics of the timber in these two groups. The trees in group 2 were treated as large-dimension ones.

The measurement results were complemented by computing the following features: taper of the trees along their merchantable bole sections (according to the Polish standards, a merchantable bole is the section extending from the stem base to the stem diameter of 7 cm over bark), volume of the merchantable boles under bark and the relative height of the crown base. This was followed by determining the percentage of trees according to their tendency to change the technical quality of the stem, the share of trees with particular types of defects and, for each type of defect, the average distance from the stem base (height of location) of the first occurrence of a defect on the stem. The percentage of trees with particular types of defects was calculated assuming the number of trees with defects as the reference level (100%). Correlation coefficients were calculated between the height of location of visible unsound, not tight knots and overgrown knots – and the taper of trees as well as the relative height of crown base.

The cores were used to determine the average width of annual rings [PN-EN 1310]. This allowed for qualification of each tree to one of three groups: 1) with the average ring width up to 4 mm, 2) with the average ring width between 4 and 7 mm and 3) with the average ring width over 7 mm. In the case of the occurrence of internal rot, its kind was determined (either hard rot, without changes in wood structure, or soft rot, with changes in wood structure) [PN-EN 844-10], its range in cm was measured and the percentage of its zone was calculated with relation to the radius of the cross-section of the tree base.

When analysing the significance of differences between the two tree groups with respect to the characteristics in question, first the character of the data distribution was established (Shapiro Wilk's test) and then either parametric or non-parametric statistical tests were used [Bruchwald 1997].

RESULTS

Comparison of the statistical characteristics of the sample trees of the two groups (Table 1) reveals that, as compared with group 1, the trees in group 2 were characterized by the average breast height diameter larger by about 97%, height larger by 45%, taper larger by 55%, volume of merchantable boles under bark larger by 350% and height of crown base larger by 28% while the relative height of crown base smaller by 11%. Due to a lack of accordance of the parameters describing the sample trees with the normal distribution, the significance of differences between the two groups was analysed by means of U Mann Whitney's test. It was established that the two tree groups compared differed significantly with respect to all analysed features.

Table 1. Statistical characteristics of the selected biometric features of sample trees
Tabela 1. Statystyczna charakterystyka wybranych biometrycznych cech drzew próbnych

	D cm	H m	Zb cm/m	V bk m^3	WK m	WWK
			Group 1 – Grupa 1			
$\bar{x}$	26.44	20.83	1.09	0.54	9.83	0.46
min.	10.00	5.00	0.40	0.04	0.50	0.04
max.	39.00	38.00	2.20	1.92	29.00	0.85
δ	6.89	5.26	0.28	0.36	4.56	0.16
V%	26.04	25.26	26.04	65.39	46.38	34.35
			Group 2 – Grupa 2			
$\bar{x}$	52.04	30.09	1.69	2.46	12.56	0.41
min.	40.00	17.00	1.00	0.85	3.00	0.12
max.	100.00	51.00	3.00	6.16	33.00	0.78
δ	11.47	6.19	0.40	1.08	5.65	0.14
V%	22.04	20.57	23.73	43.66	45.02	33.59

Explanations: $\bar{x}$ – average, min. – minimum, max. – maximum, δ – standard deviation, V% – correlation coefficient, D – breast height diameter, H – height, Zb – taper, Vbk – volume of merchantable bole without bark, WK – crown height, WWK – relative crown height.

Objaśnienia: $\bar{x}$ – średnia, min. – minimum, max. – maksimum, δ – odchylenie standardowe, V% – współczynnik zmienności, D – pierśnica, H – wysokość, Zb – zbieżystość, V bk – miąższość grubizny bez kory, WK – wysokość osadzenia korony, WWK – względna wysokość osadzenia korony.

Among thicker trees, the number of items subsumed under tendency 1 (increasing) to change the technical quality of the stem was significantly smaller than in group 1 while the number of trees with tendency 2 (permanent) was larger (χ^2 = 809.235, df = 2, p = 0.0000) than in group of thinner trees. Such a result can be explained by the age of the trees, which in group 2 is more often higher than in group 1. Interestingly, the share of trees with tendency 3 (decreasing) was identical in both groups (Fig. 1), which may be due to neglect in management in the usually younger stands with trees of group 1.

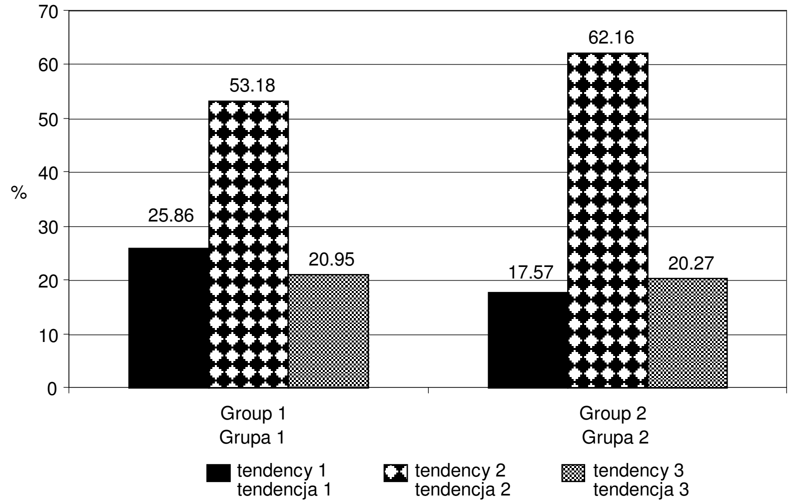

Fig. 1. Share of trees according to tendencies to change the technical quality of stems, depending on the parameters of the breast-height diameter (diameter of 1.3 m above the ground)
Rys. 1. Udział drzew według tendencji do zmiany jakości technicznej pnia w zależności od parametrów pierśnicy (średnicy na wysokości 1,30 m)

The average value of the assessment of the tendency in group 1 was calculated to be 1.95 while in group 2 it was 2.03. The statistical test (χ^2 as applied to the multipartite table) showed a significant difference between the groups (χ^2 = 9.3404, df = 2, p = 0.0094).

In the group of thinner trees, timber defects occurred on 63.13% trees whereas in the group of thicker trees as many as 83.11% trees had defects. Generally, nine kinds of timber defects were noted. Some of them, i.e. damage caused by insects, spiral grain, hollows and side cracks were subsumed under one category “other defects” due to their infrequent occurrence.

Among the most important defects, as far as the frequency of their occurrence in both groups of trees is concerned, are: unsound, not tight knots, more frequent in thicker trees, and inner rot, slightly more frequent in thinner trees. Scars and outer rot were present relatively frequently, especially in group 1; overgrown knots – burls – were noted in group 2 (Fig. 2). Differences between the two groups with respect to the frequency of occurrence of trees with particular types of defects turned out to be significant (χ^2 = 21.944, df = 7, p = 0.0026).

Extending the examination of rot by analysing the degree of timber decomposition in the cores, it was concluded that, irrespective of the tree group, hard rot was more frequent in the material analysed and that it dominated in group 1 (Fig. 3). The absolute size of inner rot, measured on the samples drilled, was almost twice larger in group 2 (Table 2) and this difference was statistically significant (U = 8824.00, p = 0.0000). The percentage of the zone of rot, calculated on the radius of the cross-section of tree bases, was similar in both tree groups (Table 3); the statistical test did not show a difference (U = 9699.50, p = 0.2857).

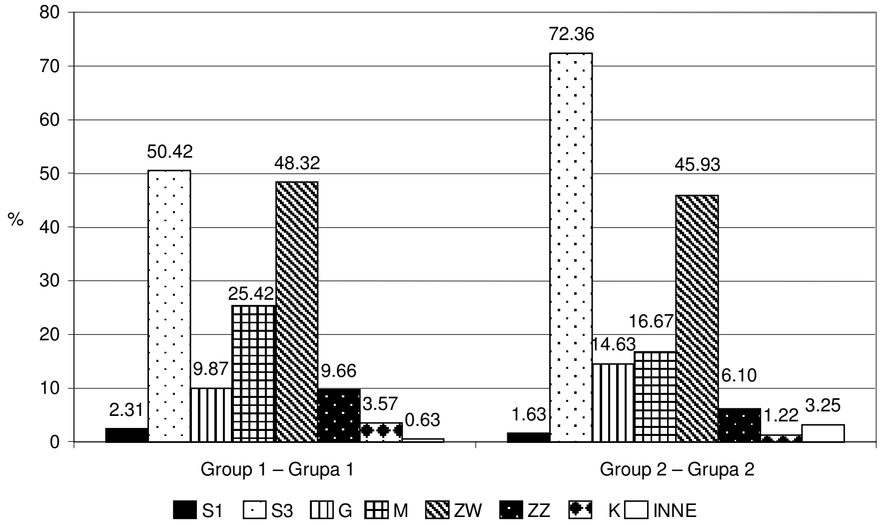

Fig. 2. Frequency of occurrence of trees with particular types of defects, depending on the parameters of the breast-height diameter (diameter of 1.3 m above the ground): S1 – sound, tight knots, S3 – unsound, not tight knots, G – burls, M – scars, ZW – internal rot, ZZ – outer rot, K – curvature, INNE – other defects
Rys. 2. Częstotliwość występowania drzew z poszczególnymi rodzajami wad w zależności od parametrów pierśnicy (średnicy na wysokości 1,30 m): S1 – sęki zdrowe zrośnięte, S3 – sęki zepsute niezrośnięte, G – guzy, M – martwice, ZW – zgnilizna wewnętrzna, ZZ – zgnilizna zewnętrzna, K – krzywizna, INNE – inne wady

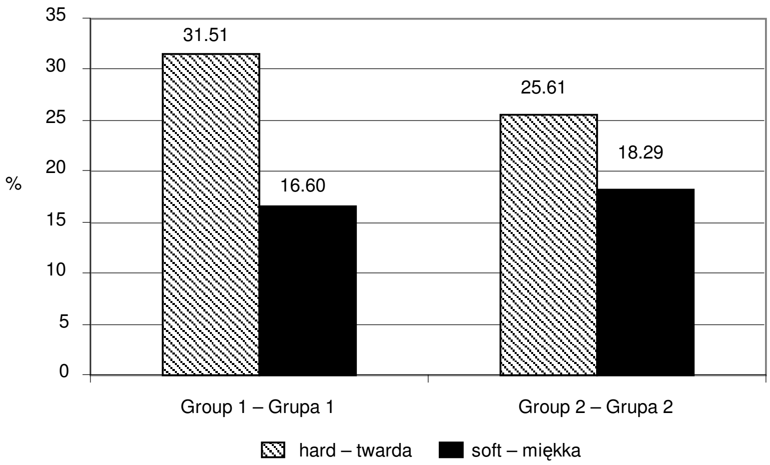

Fig. 3. Share of trees with inner rot, depending on the parameters of the breast-height diameter (diameter of 1.3 m above the ground)
Rys. 3. Udział drzew ze zgnilizną wewnętrzną w zależności od parametrów pierśnicy (średnicy na wysokości 1,30 m)

Table 2. Basic statistical characteristics of internal rot along the radius of predicted surface of cut back of trees, cm
Tabela 2. Podstawowe charakterystyki statystyczne zgnilizny wewnętrznej na promieniu w przewidywanej płaszczyźnie ścięcia drzew, cm

	Group 1 – Grupa 1	Group 2 – Grupa 2
x̄	5.20	9.96
min.	1.00	1.00
max.	20.00	37.00
δ	4.14	8.97
V%	79.51	89.98

Explanations as in Table 1.
Objaśnienia jak do tabeli 1.

Table 3. Statistical characteristics of the share of internal rot along the radius of predicted surface of cut back of trees, %
Tabela 3. Charakterystyka statystyczna udziału zgnilizny wewnętrznej na promieniu w przewidywanej płaszczyźnie ścięcia drzew, %

	Group 1 – Grupa 1	Group 2 – Grupa 2
x̄	33.17	32.21
min.	4.17	2.44
max.	100.00	100.00
δ	24.85	27.65
V%	74.91	85.84

Explanations as in Table 1.
Objaśnienia jak do tabeli 1.

The height of the location of the first occurrence of a defect under analysis on tree stems was similar in both groups (Fig. 4). The statistical tests did not show any significant differences in any comparison performed (value U from 270.50 to 21078.00; value p from 0.1656 to 0.8161, for sound, tight knots with the normal distribution $t = -0.0358$, $p = 0.9721$).

A relatively greatest (although statistically insignificant) difference in the height of location was noted for outer rot, located higher on the stems of thinner trees. Very small differences in the height of location were found for knots and internal rot; for the latter in both groups as many as 97% cases were located at the stem base.

Spearman's correlation coefficients calculated ($p = 0.10$) indicate a significant relation between taper and the height of location of overgrown knots (burls) in both tree groups altogether ($R = -0.2943$, $p = 0.1040$) as well as between taper and the height of location of unsound, not tight knots in group 1 and in both tree groups altogether (respectively $R = -0.1959$, $p = 0.0049$ and $R = -0.0946$, $p = 0.076$). The relative height of crown base and the height of location of burls in group 2 and in both groups of trees altogether were positively correlated ($R = 0.5754$, $p = 0.0818$ and $R = 0.3149$, $p = 0.845$).

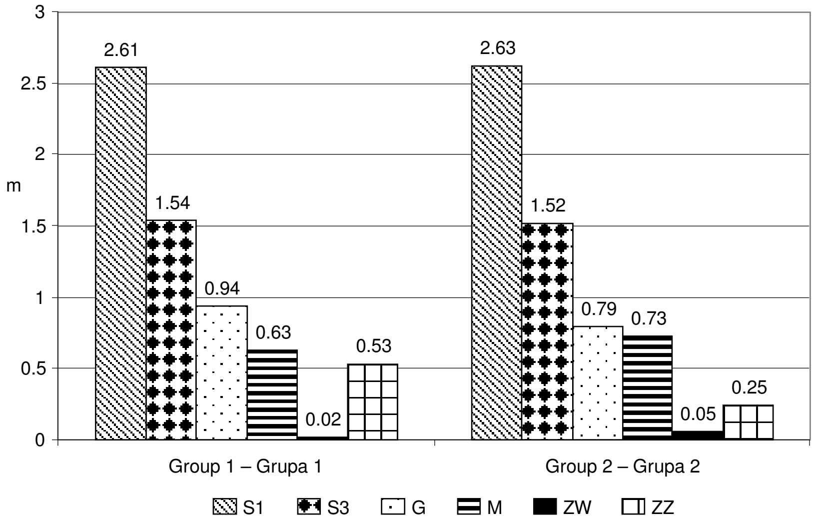

Fig. 4. Height of location of timber defects on spruce stems, depending on the parameters of the breast-height diameter (diameter of 1.3 m above the ground): S1 – sound, tight knots, S3 – unsound, not tight knots, G – burls, M – scars, ZW – internal rot, ZZ – outer rot
Rys. 4. Wysokość położenia wad drewna na strzałach świerka pospolitego w zależności od parametrów pierśnicy (średnicy na wysokości 1,30 m): S1 – sęki zdrowe zrośnięte, S3 – sęki zepsute niezrośnięte, G – guzy, M – martwice, ZW – zgnilizna wewnętrzna, ZZ – zgnilizna zewnętrzna

Thicker trees, analysed with respect to annual ring width, showed a higher share of items with small increments: up to 4 mm (Fig. 5); differences in the share of trees belonging to the groups distinguished on the basis of annual ring width turned out to be statistically insignificant (χ^2 = 3.4749, df = 2, p = 0.1760).

DISCUSSION

The reason why the present research was undertaken was a recent interest on the part of scientists and practicians in the quality and possibilities of processing of timber from trees with large dimensions. Already in the 1980s, Kärkkäinen [1986] created mathematical models to determine the value of spruce and pine timber (considering its thickness) to be used in sawmills and cellulose production in Finland. The results of his research showed that spruce timber quality, expressed by an average value of 1 m^3, was positively correlated with the breast height diameter, which ranged between 19 and 43 cm in the material analysed.

Research carried out in Norway [Vestøl and Høibø 1998] revealed that the breast height diameter can be used as a predictor of the length and diameter of knots in Norway spruce. An increase in breast height diameter was accompanied by an increase in the length of sound knots; a positive correlation was noted between the diameters of knots

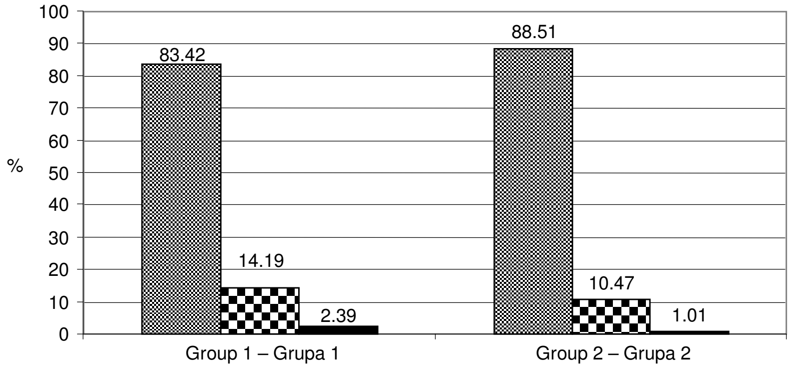

Fig. 5. Share of trees with different annual ring width, depending on the parameters of the breast-height diameter (diameter of 1.3 m above the ground): ▒ – group with average width up to 4 mm, ▞ – group with average width between 4 and 7 mm, ■ – group with average width over 7 mm
Rys. 5. Udział drzew o zróżnicowanej szerokości przyrostów rocznych w zależności od parametrów pierśnicy (średnicy na wysokości 1,30 m): ▒ – średnia szerokość przyrostów do 4 mm, ▞ – średnia szerokość przyrostów 4 do 7 mm, ■ – średnia szerokość przyrostów ponad 7 mm

located on the stem below the crown and the width of annual rings on the level of breast height diameter. This may suggest depreciation of timber quality in relation to the occurrence of knots along with increasing tree thickness.

In the present research knot diameters were not measured. The feature which influenced timber quality was only the height of location of this defect. The average height of location of knots was similar in both tree groups. In the group of thicker trees, overgrown knots were located lower than in the group of thinner trees. In the material under analysis, in thicker trees, characterized by significantly larger taper and volume of merchantable boles and by a smaller relative height of crown base, visible knots and symptoms of overgrovn knots – defects which limit the possibility to obtain better quality classes – occurred more often than in thinner trees. These two defects were also the main reason for a greater share of trees with defects in group 2 and for a relatively high share of trees qualified there to tendency “permanent”. This complex of features may be caused by a small density of trees in a unit of area and by difficulty for dead branches to fall off tree stems.

In her previous research, Barszcz [1995] showed a negative correlation between the height of location of knots and taper of spruce stems as well as the positive correlation between the height of location of knots and relative height of crown base; then these relations were described by means of equations of regression. The calculated correlation coefficient allowed for a conclusion that those findings are similar to the results of the present research. It was determined that the height of location of both overgrown knots and visible unsound, not tight knots depended significantly on the taper of trees (a negative correlation); moreover, the height of location of burls was significantly related to the relative height of crown base (a positive correlation). These relations confirm a possibility on the part of foresters to affect the shape of the stem and the features of knottiness by regulating the degree of density of trees in a stand.

In the material analysed, scars and outer rot were discovered more often in thinner trees. Both of these defects frequently co-occur on the same trees; the appearance of scars, especially in the butt-ends, is in the mountains usually due to damage caused by timber extraction [Barszcz 1999]. Less frequent recording of these defects on thicker (and usually older) trees may be due to damage being overgrown by new annual rings, to better protection provided by thicker bark of these trees and perhaps also to early, systematic removal of damaged trees done in order to prevent timber depreciation on the stem. Thicker trees had larger absolute zones of internal rot and, more often than in thinner trees, it was soft rot, with a large degree of wood decomposition. This defect is hard to detect in standing trees which were the subject of the research, until there occur clear symptoms of weakening of these trees and of the development of fungi.

SUMMING UP AND CONCLUSION

1. On the example of spruce timber from the Beskidy Mts, it was concluded that the two groups of spruce distinguished for research purposes differed significantly as to the size, volume and taper of merchantable boles as well as the relative and absolute height of crown base.

2. Thicker trees showed a significantly weaker structure of the tendencies to change the technical quality of the stem and a larger overall share of items with defects. In the lower part of their stems, which was analysed, they had unsound and not tight knots and burls more often than thinner trees but they had fewer cases of scars, rot and curvatures. The absolute size of internal rot was nearly twice larger in thicker trees than in thinner ones; as in thinner trees, this usually was hard rot.

3. The groups of trees compared did not differ significantly with respect to the height of location of first occurrences of defects; particularly small differences were found in the case of the location of knots and the inner rot which was located very low. No significant differences were found in the width of annual rings although thicker trees tended to form timber with narrower rings.

4. The differentiation of the quality of the spruce timber under analysis reveals that, in the research area, to some extent both the structure of defect types and some of their sizes considered were specifically related to the thickness of the timber. Extending the research area and complementing the research with analyses of the quality of felled stems may offer a more complete view of the quality of large-dimensioned timber and in this way help customers to use it more rationally.

REFERENCES

Barszcz A., 1999. An analysis of the relations between wood defects. Zesz. Nauk. AR Krak., Leśn. 28, 5-16.

Barszcz A., 1988. Możliwości porównywania jakości technicznej drzewostanów różnych faz rozwoju [Possibilities of comparison of technical quality of stands in different development stages]. Sylwan 11/12, 41-47 [in Polish].

Barszcz A., 1995. Ocena jakości surowca drzewnego i zmienności wad drewna w rębnych drzewostanach świerkowych na terenie Beskidów [Assessment of timber quality and timber defect variability in mature spruce stands in the Beskidy Mts]. Zesz. Nauk. AR Krak., Rozpr. 199 [in Polish].

Barszcz A., 2004. Zróżnicowanie wartości użytkowej surowca drzewnego lasów Żywiecczyzny [Differentiation of utility value of timber in the forests of the Żywiecczyzna Region]. Projekt badawczy KBN, P06L 015 21. Sprawozdanie końcowe. Kat. Użytk. Lasu Drewn. AR, Kraków [in Polish].

Bruchwald A., 1997. Statystyka matematyczna dla leśników [Mathematical statistics for foresters]. SGGW Warszawa [in Polish].

Kärkkäinen M., 1986. Mänty- ja kuusirunkojen arvosuhteet [Value relations of pine and spruce stems]. Silva Fen. 20, 2, 117-127 [in Finnish].

Kołodziejczyk M., Zubkowicz R., 2006. Przeszłorębne do eksploatacji [Overmatured stands for utilization]. Las Pol. 19, 16-17 [in Polish].

Plany urządzenia gospodarstwa leśnego nadleśnictw: Bielsko, Jeleśnia, Ujsoły, Węgierska Górka, Wisła, obowiązujące w latach 2001-2003 [Forest management plans of districts: Bielsko, Jeleśnia, Ujsoły, Węgierska Górka, Wisła, obliged in 2001-2003; in Polish].

PN-EN 1310. 2000. Metody pomiaru cech [Methods of measurement of features]. CEN, PKN [in Polish].

PN-EN 844-10. 2001. Terminologia. Terminy dotyczące przebarwień i uszkodzeń grzybowych [Terminology. Terms relating to stain and fungal attack]. CEN, PKN [in Polish].

PN-79/D-01011. 1980. Drewno okrągłe. Wady [Round timber. Defects]. Wyd. Normalizacyjne Warszawa [in Polish].

Raport o stanie lasów w Polsce [State of the forest report]. 2006. IBL, CILP Warszawa [in Polish].

Vestøl G.I., Høibø O.A., 1998. Internal distribution of sound and dead knots in *Picea abies* (L.) Karst. In: Single-tree models of knot properties in Norway spruce (*Picea abies* (L.) Karst.). Doctor scientiarum theses 34. Agric. Univ. Norway.

Vestøl G.I., Høibø O.A., 1998. Prediction of knot diameter in *Picea abies* (L.) Karst. In: Single--tree models of knot properties in Norway spruce (*Picea abies* (L.) Karst.). Doctor scientiarum theses 34. Agric. Univ. Norway.

JAKOŚĆ SUROWCA ŚWIERKOWEGO Z DRZEW ZRÓŻNICOWANYCH GRUBOŚCIOWO Z TERENU BESKIDÓW

Streszczenie. Postępujący proces starzenia się drzewostanów w Polsce i w Europie pozwala prognozować wzrost podaży drewna o dużych dymensjach. W pracy porównano wybrane cechy jakościowe drewna drzew o dużych pierśnicach (równych lub większych od 40 cm) z cechami drewna drzew cieńszych, na przykładzie świerka pospolitego z terenu Beskidów. Grupa świerków grubszych (pierśnice 40 cm i większe) charakteryzowała się większą liczbą sztuk z wadami drewna, w tym z sękami otwartymi i symptomami zarośniętych sęków, natomiast w porównaniu z drzewami cieńszymi mniejszą liczbą drzew z martwicami, zgniliznami i krzywiznami. Bezwzględny rozmiar zgnilizny na przekroju poprzecznym pnia był większy u drzew grubszych. Charakteryzowały się też one mniejszą średnią szerokością przyrostów rocznych. Porównywane grupy nie różniły się istotnie wysokością położenia pierwszych wad na pniach drzew.

Słowa kluczowe: surowiec świerkowy, drzewa grubsze i cieńsze, wady drewna

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