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PROPERTIES OF SCOTS PINE (*PINUS SYLVESTRIS* L.) TIMBER GROWING ON FORMER ARABLE AND FOREST LAND

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Abstract. The study presents results of investigations in which attempts were made to determine and compare the conventional density and compression strength along wood fibres of Scots pine (*Pinus sylvestris* L.) developed on former farmland and on typical forest soils. The analyses comprised two forest site types: fresh coniferous forest (FCF) and fresh mixed coniferous forest (FMCF). The conventional density and compression strength along fibres were studied. It was found that the timber conventional density of pines grown in conditions of former farmland was higher than that of the pines derived from typical forest soils. The performed studies revealed distinct correlations between the compression strength along fibres and wood conventions density both in pines derived from the former farmland and from the typical forest soils of both analysed forest site types. The correlation between the examined properties was found stronger in the case of the typical forest soils (FCF r = 0.93; FMCF r = 0.88) and weaker, in the case of the former farmland (FCF r = 0.48; FMCF r = 0.42). It should be emphasised that the heartwood of pine trees which grew on the former farmland in conditions of the FMCF was characterised by different properties. At high density, this wood exhibited low compression strength along fibres. The wood derived from trees developed in conditions of the former farmland did not show differences in its macrostructure in comparison with the wood derived from forest sites.

Key words: conventional density, compression strength along fibres, Scots pine, former farmland, forest land

INTRODUCTION

In spite of the observed steady improvement of the age class structure, volume and other parameters indicating growing productivity of stands in Poland, it is almost certain that the supply of timber raw material in the foreseeable future will undergo changes. These changes will be the result, primarily, of the necessity to process the timber raw

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material from tending and sanitary cuts as well as of changes in the approach to monoculture forest systems and the resulting reconstruction of forest stands. We are going to observe increased supplies of timber raw material originating from stands of various age classes, including afforestation of former farmland which earlier remained outside forest plantations.

According to the data of the Main Statistical Office (GUS), the total area of afforestation of farmland unsuitable for farming as well as wasteland in years 1945-1998 reached 1 279.8 thousand hectares, of which 480 000 ha (37.5%) were afforested in years 1945-1960, which means that these forests are now 40 years old or older [Budna and Grzybowska 1999].

The increase of the woodiness of Poland to 30% by 2020 will be connected with the afforestation of land excluded from agricultural production. This was the principal idea which was behind the elaboration of the "National Program of the Increase of Woodiness" approved for realisation by the government which adopted a resolution during the session of the Council of Ministers in June 1995 [Puchniarski 2000].

Hypothetically, it was assumed that timber of the pine tree which developed on former agricultural land differs with regard to a number of traits from the timber of trees which grew on typical forest land. This dissimilarity of traits of the timber raw material derived from the former farmland can, in some circumstances, either limit or even exclude its utilisation or application.

The aim of this study was to try and determine and compare selected properties of Scots pine (*Pinus sylvestris* L.) timber derived from trees developed on former farmland or forest soils.

The study analyses two basic properties which allow assessing the value of raw materials, namely: wood density and compression strength along fibres.

Wood density indicates its mechanical properties as well as its yield as the raw material utilised in chemical and physico-chemical processing [Krzysik 1978, Haygreen and Bowyer 1996]. With the increase of wood density, some of its mechanical properties improve and the output of products obtained from it increases. Therefore, it constitutes an important physical property of wood because it can influence possibilities of its utilization.

The compression strength along fibres is easy to determine and allows drawing conclusions about other mechanical properties. This is why it provides a good indicator of wood technical properties [Krzysik 1978, Haygreen and Bowyer 1996, Kollman and Cote 1968].

RESEARCH MATERIAL AND METHODS

Investigations were carried out in the Miastko Forest Division in pine stands of the Vth and VIth age class developed on former farmland and typical forest soils in conditions of the following forest site types: fresh coniferous forest (FCF) and mixed fresh coniferous forest (MFCF).

Breast height diameters of all growing trees as well as their heights proportionally to the number in the assumed (2 cm) degrees of thickness were measured on the established experimental plots of 0.5 ha area each.

After establishing the thickness-height characteristics of trees with the Urich ll method [Grochowski 1973], dimensions of mean sample trees were determined and selected for each experimental plot. The total of 12 trees were selected, i.e. 3 trees for each plot. The sample trees represented the three first Kraft classes, two trees from each class. Next the selected trees were cut and material was taken for further analyses. Materials from which samples for the investigations on wood conventional density and compression strength along fibres derived were parts from pith planks obtained after sawing 5 m long butt-end logs of individual sample trees. Wood density was ascertained using the stereometric method. It was determined as conventional density on samples which were later used for investigations on the compression strength along fibres.

The compression strength along wood fibres was determined on the Tira Test 2300 testing machine equipped in the Matest Service Company computer software. All assays were carried out with the accuracy of 0.01 MPa. The sample strength was determined at the wood moisture content above the fibre saturation point. This strength, also referred to as 'the strength of wet wood' or 'basic strength', shows the true wood quality as construction material and depends on primary bonds [Grzeczyński 1975, 1985, Grzeczyński and Perkitny 1979].

Assays of selected timber properties were performed separately for Scots pine trees derived from the former farmland and forest land and separately for sapwood and heartwood.

Wood moisture content was determined using the drier-gravimetric method (PN-77/ D-04100).

The investigations of timber properties were conducted in accordance with the assumptions of appropriate standards (PN-77/D-04101, PN-79/D-04102).

The obtained empirical material was analysed using methods of mathematical statistics employing, for this purpose, the Statistica 6 PL statistical program.

RESEARCH RESULTS

Research results (Table 1 and Fig. 1) indicate that both sapwood and heartwood of pine trees grown on the former farmland in conditions of the FCF and MFCF were characterised by higher density than the wood developed on forest soils. In the case of sapwood, the difference ranged from about 6% to 9% and this difference was found higher in the wood which developed in conditions of the FCF. In the case of heartwood, the difference in the conventional density ranged from over 14% to 20%. The difference in the density was higher on the MFCF than on the FCF. In the case of sapwood, differences between the wood density of pine trees developed on the former farmland and those which grew on forest soils were not significant. Significant differences were found with regard to the heartwood conventional density (Table 2).

The conventional density variability (Table 1) remained at 3.2% to 21.1% interval. In the case of the sapwood derived from pine trees from the former farmland, it ranged from 5.3% to 16.7%, whereas for the heartwood – from 9.8% to 21.1%. In the case of trees which grew on typical forest soils, the above parameter for the sapwood ranged from 3.2% to 8.4%, while for the heartwood – from 10.1% to 13.7%.

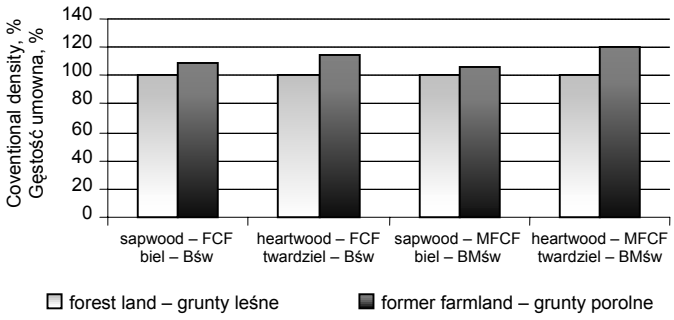

Fig. 1. Comparison of conventional density of Scots pine wood developed on FCF and MFCF forest site types in conditions of former farmland and forest soils (reference level = 100%)
Rys. 1. Porównanie gęstości umownej drewna sosny zwyczajnej wyrosłej na siedlisku Bśw i BMśw w warunkach gleb porolnych i leśnych (poziom odniesienia = 100%)

Table 1. Statistical characteristics of conventional density of Scots pine timber (*Pinus sylvestris* L.) developed on former farmland and forest soils in the FCF and MFCF site conditions, kg/m^3
Tabela 1. Charakterystyka statystyczna gęstości umownej drewna sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na glebach porolnych i leśnych w warunkach Bśw i BMśw, kg/m^3

Type of soil Rodzaj gruntu	Forest site type Siedliskowy typ lasu	Wood Drewno	Measures of position and dispersion Miary położenia i rozproszenia				
			medium średnia kg/m^3	standard deviation odchylenie standartowe	variability coefficient współczynnik zmienności %	values minimum minimum	values maximum maksimum
Former farmland Porolny	FCF Bśw	sapwood – biel	463	24.63	5.32	440	530
		heartwood – twardziel	481	47.31	9.84	430	570
	MFCF BMśw	sapwood – biel	475	79.29	16.71	410	660
		heartwood – twardziel	503	106.38	21.14	360	700
Forest Leśny	FCF Bśw	sapwood – biel	425	13.82	3.25	400	450
		heartwood – twardziel	420	42.43	10.10	330	480
	MFCF BMśw	sapwood – biel	447	37.54	8.40	380	510
		heartwood – twardziel	418	57.32	13.72	310	510
Average Średnio	FCF Bśw	sapwood – biel	444	27.53	6.20	420	490
		heartwood – twardziel	450.5	49.02	10.88	380	525
	MFCF BMśw	sapwood – biel	461	57.76	12.53	395	585
		heartwood – twardziel	460.5	88.82	19.29	335	605

Table 2. RIR test results for the heartwood conventional density
Tabela 2. Wyniki testu RIR dla gęstości umownej twardzieli

			Former farmland Porolne Sapwood Biel FCF Bśw	Former farmland Porolne Heartwood Twardziel FCF Bśw	Former farmland Porolne Sapwood Biel MFCF BMśw	Former farmland Porolne Heartwood Twardziel MFCF BMśw	Forest Leśne Sapwood Biel FCF Bśw	Forest Leśne Heartwood Twardziel FCF Bśw	Forest Leśne Sapwood Biel MFCF BMśw	Forest Leśne Heartwood Twardziel MFCF BMśw
Former farmland Porolne	sapwood biel	FCF Bśw		0.4293	0.6271	0.0590	0.1089	**0.0458**	0.4649	**0.0286**
Former farmland Porolne	heartwood twardziel	FCF Bśw	0.4293		0.7976	0.2888	**0.0190**	**0.0050**	0.1233	**0.0025**
Former farmland Porolne	sapwood biel	MFCF BMśw	0.6271	0.7976		0.2091	**0.0486**	**0.0183**	0.2380	**0.0110**
Former farmland Porolne	heartwood twardziel	MFCF BMśw	0.0590	0.2888	0.2091		**0.0006**	**0.0001**	**0.0067**	**0.0000**
Forest leśne	sapwood biel	FCF Bśw	0.1089	**0.0190**	**0.0486**	**0.0006**		0.8222	0.3382	0.7343
Forest Leśne	heartwood twardziel	FCF Bśw	**0.0458**	**0.0050**	**0.0183**	**0.0001**	0.8222		0.1917	0.9046
Forest Leśne	sapwood biel	MFCF BMśw	0.4694	0.1233	0.2380	**0.0067**	0.3382	0.1917		0.1391
Forest leśne	heartwood twardziel	MFCF BMśw	**0.0286**	**0.0025**	**0.0110**	**0.0000**	0.7343	0.9046	0.1391	

Results are significant at the level of P smaller or equal 0.05.
Wyniki są istotne na poziomie p mniejszym lub równym 0,05.

Statistical characteristics as well as mean wood values of compression along fibres above the saturation level of cell walls for the sapwood and heartwood are presented in Table 3 and Figure 2. It is evident from these data that the mean timber strength of pine trees which grew on the former farmland in conditions of the FCF was higher than that of pine trees developed on forest soils by about 15% in the case of sapwood and over 19% for heartwood. In conditions of the MFCF site type, the sapwood of pine trees form the former farmland exhibited a slightly higher (by about 4%) strength than the wood from forest soils. A reverse situation was observed in the case of the heartwood. The strength of timber derived from trees developed on typical forest soils was higher than that derived from the trees which grew on the former farmland. The difference reached 14.7% (Fig. 2).

The sapwood strength variability coefficient ranged from 10.5% to 15.6%, while that of heartwood – from about 10% to 22.1%. This variability in the case of pine trees derived from the former farmland ranged from about 15% to 15.4% for the sapwood and from about 10% to 12.5% for the heartwood. These values for the trees which grew in conditions of typical forest soils were: from 10% to 15.6% and from 15.6% to 22.1%, respectively (Table 3).

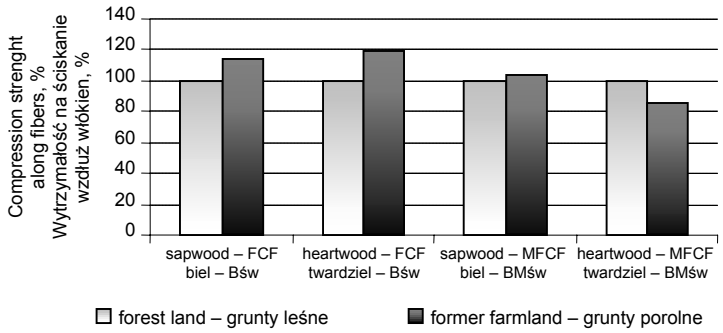

Fig. 2. Comparison of compression strength along fibres above cell wall saturation point of Scots pine wood developed on the FCF and MFCF sites in conditions of former farmland and forest soils (reference level = 100%)
Rys. 2. Porównanie wytrzymałości na ściskanie wzdłuż włókien powyżej punktu nasycenia ścian komórkowych drewna sosny zwyczajnej wyrosłej na siedlisku Bśw i BMśw w warunkach gleb porolnych i leśnych (poziom odniesienia = 100%)

Table 3. Statistical characteristics of the compression strength along fibres above cell wall saturation point of Scots pine (*Pinus sylvestris* L.) wood developed on former farmland and forest soils in conditions of FCF and MFCF sites, MPa
Tabela 3. Charakterystyka statystyczna wytrzymałości drewna na ściskanie wzdłuż włókien powyżej punktu nasycenia ścian komórkowych u sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na glebach porolnych i leśnych w warunkach Bśw i BMśw, MPa

Type of soil Rodzaj gruntu	Forest site type Siedliskowy typ lasu	Wood Drewno	Measures of position and dispersion Miary położenia i rozproszenia				
			medium średnia kg/m^3	standard deviation odchylenie standartowe	variability coefficient współczynnik zmienności %	values minimum minimum	values maximum maksimum
Former farmland Porolny	FCF Bśw	sapwood – biel	21.65	3.33	15.36	13.17	26.45
		heartwood – twardziel	24.72	2.46	9.95	20.64	30.19
	MFCF BMśw	sapwood – biel	20.89	3.13	14.98	15.65	25.57
		heartwood – twardziel	16.24	2.03	12.49	12.72	19.26
Forest Leśny	FCF Bśw	sapwood – biel	18.88	1.99	10.53	16.48	21.76
		heartwood – twardziel	20.71	3.24	15.63	13.35	24.68
	MFCF BMśw	sapwood – biel	20.04	3.13	15.62	15.11	26.06
		heartwood – twardziel	19.04	4.21	22.1	9.76	24.65
Average Średnio	FCF Bśw	sapwood – biel	20.27	3.14	15.49	14.83	24.11
		heartwood – twardziel	22.72	4.31	18.97	17.00	27.44
	MFCF BMśw	sapwood – biel	20.47	3.37	16.47	15.38	25.82
		heartwood – twardziel	17.64	4.56	25.85	11.24	21.96

A significant difference in the compression strength along fibres on the FCF site occurred between both sapwood and heartwood timber derived from trees which grew on the former farmland and those which developed on typical forest soils. In the case of the MFCF, significant differences in strength occurred only with regard to the heartwood and these differences were not significant for the sapwood (Table 4).

Table 4. RIR test results for the compression strength along fibres
Tabela 4. Wyniki testu RIR dla wytrzymałości na ściskanie wzdłuż włókien

			Former farmland Porolne Sapwood Biel FCF Bśw	Former farmland Porolne Heartwood Twardziel FCF Bśw	Former farmland Porolne Sapwood Biel MFCF BMśw	Former farmland Porolne Heartwood Twardziel MFCF BMśw	Forest Leśne Sapwood Biel FCF Bśw	Forest Leśne Heartwood Twardziel FCF Bśw	Forest Leśne Sapwood Biel MFCF BMśw	Forest Leśne Heartwood Twardziel MFCF BMśw
Former farmland Porolne	sapwood biel	FCF Bśw		**0.0102**	0.5450	**0.0000**	**0.0254**	0.3991	0.1587	**0.0155**
Former farmland Porolne	heartwood twardziel	FCF Bśw	**0.0102**		**0.0028**	**0.0000**	**0.0000**	**0.0004**	**0.0001**	**0.0000**
Former farmland Porolne	sapwood biel	MFCF BMśw	0.5450	**0.0028**		**0.0002**	0.1244	0.8818	0.4847	0.1099
Former farmland Porolne	heartwood twardziel	MFCF BMśw	**0.0000**	**0.0000**	**0.0002**		**0.0244**	**0.0000**	**0.0005**	**0.0054**
Forest leśne	sapwood biel	FCF Bśw	**0.0254**	**0.0000**	0.1244	**0.0244**		0.1167	0.3227	0.8870
Forest Leśne	heartwood twardziel	FCF Bśw	0.9910	**0.0004**	0.8818	**0.0000**	0.1167		0.5279	0.0933
Forest Leśne	sapwood biel	MFCF BMśw	0.1587	**0.0001**	0.4847	**0.0005**	0.3327	0.5279		0.3316
Forest leśne	heartwood twardziel	MFCF BMśw	**0.0155**	**0.0000**	0.1099	**0.0054**	0.8870	0.0933	0.3316	

Results are significant at the level of P smaller or equal 0.05.
Wyniki są istotne na poziomie p mniejszym lub równym 0,05.

In the presented study, the dependence of the heartwood compression strength along fibres above the membrane saturation point on its conventional density was characterised using the correlation (r) and determination (r^2) coefficients. The results of calculations are presented in Table 5 and in Figures 3 to 6. It is evident from them that the linear effects were very high and average and this correlation is of rectilinear nature, as evident in Figures 3 to 6. High correlation coefficients occurred in pine trees derived from typical forest soils, both in the case of the FCF and MFCF sites. These values were, respectively: r = 0.93; r = 0.88. In the case of trees derived from the former farmland, the correlation coefficient in conditions of the poorer site reached the value of r = 0.48 and in the more fertile one – r = 0.42. In the case of pine trees developed in conditions of typical forest soils, the correlation coefficient was also high at the level of significance lower than 0.05.

On the basis of the calculated determination coefficients, it should be stated that, in the case of pine trees which developed on typical forest soils, the heartwood strength depended on its density in 87% in conditions of the FCF and in 77% – in conditions of the MFCF. On the other hand, this parameter in trees which derived from the former farmland depended on density in 24% in conditions of the FCF and in 17% in the MFCF (Table 5).

Table 5. Correlation between the strength and density of pine timber developed in different site conditions on the former farmland and typical forest soil
Tabela 5. Zależność pomiędzy wytrzymałością a gęstością drewna sosen wyrosłych w zróżnicowanych warunkach siedliskowych na gruntach porolnych i leśnych

Type of land Rodzaj gruntu	FST STL	Property Właściwości	Mean Średnia	Standard deviation Odchylenie standardowe	Variability coefficient Współczynnik zmienności %	r(x,y)	r2	t	Constant Stała	Slope Nachylenie
Former farmland Porolny	FCF Bśw	density gęstość	480	50	10.42	0.48*	0.24	1.920	12.61	25.2
		strength wytrzymałość	24.72	2.46	9.95					
	MFCF BMśw	density gęstość	500	110	22.00	0.42*	0.17	1.830	12.25	7.93
		strength wytrzymałość	16.24	2.03	12.94					
Forest Leśny	FCF Bśw	density gęstość	420	40	9.52	0.93**	0.87	10.227	–9.14	71.07
		strength wytrzymałość	20.71	3.24	15.63					
	MFCF BMśw	density gęstość	420	60	14.29	0.88**	0.77	8.252	–7.92	64.55
		strength wytrzymałość	19.04	4.21	22.10					

*Correlation significance at the level alfa = 0.05.

**Correlation significance at the level alfa = 0.01.

*Istotność korelacji na poziomie alfa = 0,05.
**Istotność korelacji na poziomie alfa = 0,01.

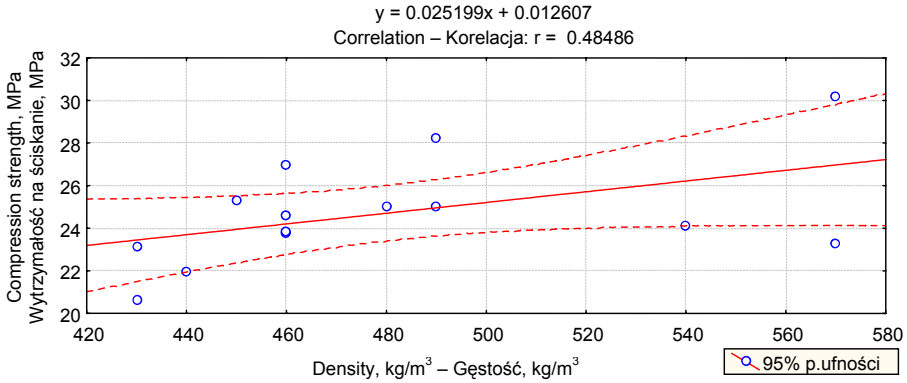

Fig. 3. Dependence of the heartwood compression strength along fibres on its density in Scots pine (*Pinus sylvestris* L.) developed on former farmland in conditions of FCF
Rys. 3 Zależność wytrzymałości drewna twardzielowego na ściskanie wzdłuż włókien od jego gęstości u sosny zwyczajnej *(Pinus sylvestris L.)* wyrosłej na gruntach porolnych w warunkach boru świeżego

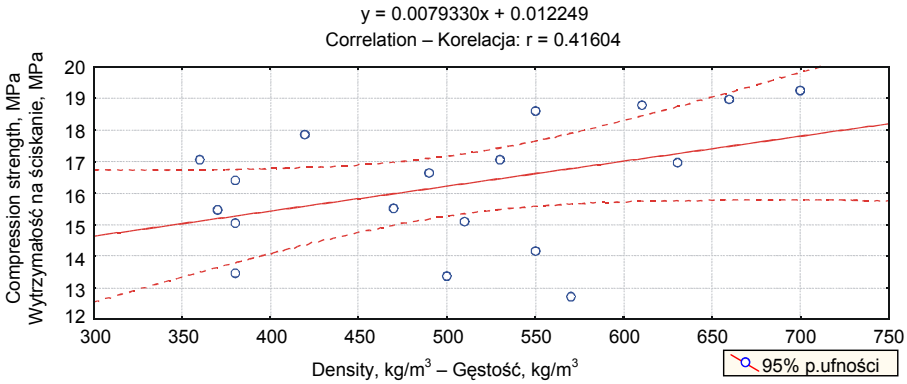

Fig. 4. Dependence of the heartwood compression strength along fibres on its density in Scots pine (*Pinus sylvestris* L.) developed on former farmland in conditions of MFCF
Rys. 4. Zależność wytrzymałości drewna twardzielowego na ściskanie wzdłuż włókien od jego gęstości u sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na gruntach porolnych w warunkach boru mieszanego świeżego

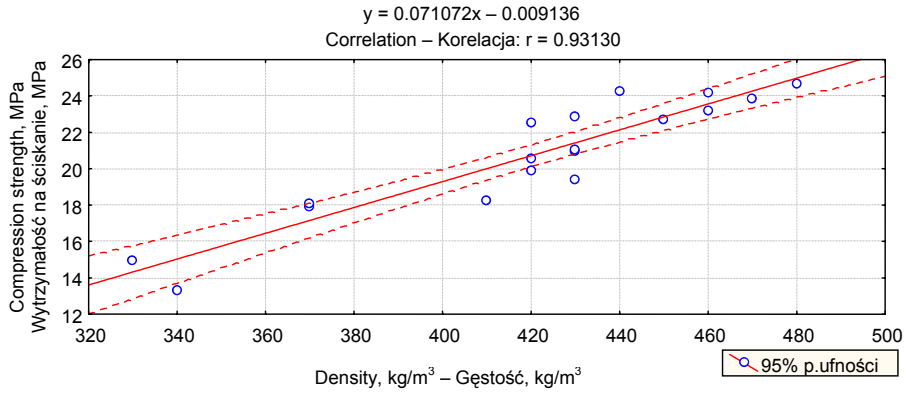

Fig. 5. Dependence of the heartwood compression strength along fibres on its density in Scots pine (*Pinus sylvestris* L.) developed on forest soils in conditions of FCF
Rys. 5. Zależność wytrzymałości drewna twardzielowego na ściskanie wzdłuż włókien od jego gęstości u sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na gruntach leśnych w warunkach boru świeżego

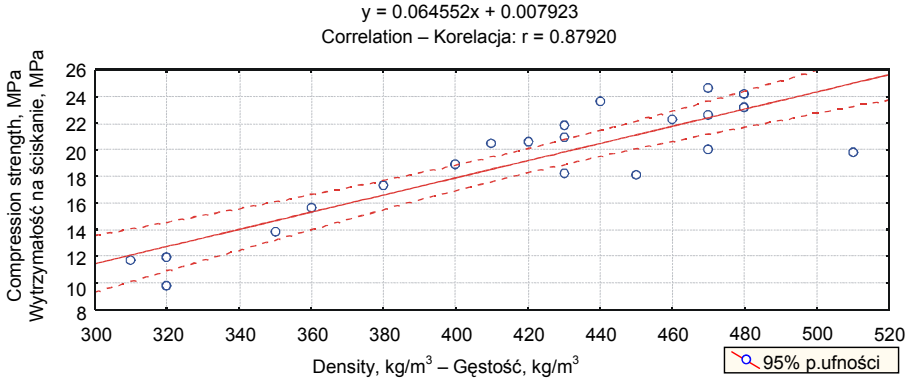

Fig. 6. Dependence of the heartwood compression strength along fibres on its density in Scots pine (*Pinus sylvestris* L.) developed on forest soils in conditions of MFCF
Rys. 6 Zależność wytrzymałości drewna twardzielowego na ściskanie wzdłuż włókien od jego gęstości u sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na gruntach leśnych w warunkach boru mieszanego świeżego

DISCUSSION

According to literature data, both timber density and strength of coniferous species horizontally increases in the direction from the pith towards the circumference [Krzysik 1978]. This is associated with the gradual narrowing of the annual ring accompanied by a

simultaneous increase of the latewood. It follows that the sapwood part of the trunk should be characterised by both greater density and strength.

The performed investigations corroborated this opinion but only with regard to stands which developed on typical forest soils where, in the case of both forest site types, the sapwood part of timber was characterised by a greater density than the heartwood part. The observed greater strength of the heartwood in the FCF site type in comparison with the MFCF was probably caused by a lower dynamics of the thickness increment in the part of the trunk where this wood occurred. A strong correlation was also observed here between wood density and compression strength along fibres which is also reported in literature.

In the case of stands developed in conditions of the former farmland, these properties were of a different nature. The higher density of the heartwood part appeared to indicate that it was also characterised by higher strength. However, it was true only in the case of the FCF. A considerable decrease of the heartwood strength recorded in the case of the MFCF raises a number of questions. It may be assumed that the unstable growth and development of the timber tissue on the former farmland reflected the disturbed soil structure, especially the quantitative interrelations of nutrients [Szujecki 1990, Tuszyński 1990].

The described investigations were carried out on samples with the moisture content above the fibre saturation point which allowed eliminating the impact of secondary bonds which develop in the course of the wood drying process. Therefore, it can be assumed that in the case of trees growing on former farmland changes in the structure of wood tissue occurred at the level of the cell wall. Absence of visible macrostructural changes, at different properties of the raw material, can be justified by differences in the length of cellulosic chains or the fibril inclination angle.

The problems associated with the quality of timber raw material derived from former farmland will intensify with the increase of supply of pine wood developed in these conditions. This will make customers change their approach towards its utilisation or application.

CONCLUSIONS

1. The performed investigations showed that the timber conventional density of pine trees which developed on the former farmland in conditions of the FCF and MFCF site types was significantly higher in comparison with the timber derived from typical forest soils. This referred both to sapwood and heartwood.

2. The timber compression strength along fibres above the saturation point of cell walls of pine trees which developed on the former farmland in conditions of the FCF site type was significantly higher than that of pine trees from typical forest soils. In the case of the richer site (MFCF), this correlation was different. The sapwood in trees from the former farmland exhibited a slightly higher strength than that derived from forest soils. The heartwood derived from the former farmland showed a statistically significant lower strength than the wood from the former farmland.

3. The experiments revealed a distinct correlation between the compression strength along fibres and wood conventional density of both pine trees derived from the former farmland and those from typical forest soils in both analysed forest site types. The

strength of the examined properties was stronger in the case of the typical forest site types (FCF r = 0.93; MFCF r = 0.88) and weaker in the case of the former farmland (FCF r = 0.48; MFCF r = 0.42).

4. It should be emphasised that the heartwood of pine trees developed on the former farmland in conditions of the MFCF showed different properties in comparison with the wood of trees from forest soils. At high density, this wood was characterised by significantly lower compression strength along fibres. Since this wood did not show differences in its macro structure, the authors concluded that the observed changes should be attributed to changes in the wood tissue at the level of cell wall. Therefore, further studies are necessary to elucidate this problem.

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WŁAŚCIWOŚCI DREWNA SOSNY ZWYCZAJNEJ (*PINUS SYLVESTRIS* L.) WYROSŁEJ NA GLEBACH POROLNYCH I LEŚNYCH

Streszczenie. W pracy podjęto próbę określenia i porównania gęstości umownej i wytrzymałości na ściskanie wzdłuż włókien drewna sosny zwyczajnej (*Pinus sylvestris* L.) wyrosłej na gruntach porolnych oraz typowo leśnych. Analizą objęto dwa siedliskowe typy lasu Bśw i BMśw. Rozpatrywano gęstość umowną i wytrzymałość na ściskanie wzdłuż włókien. Stwierdzono, że gęstość umowna drewna sosen wyrosłych w warunkach gruntów porolnych była większa od gęstości drewna sosen pochodzących z gleb typowo leśnych. Badania wykazały występowanie wyraźnej zależności pomiędzy wytrzymałością

na ściskanie wzdłuż włókien a gęstością umowną drewna zarówno u sosen pochodzących z gruntów porolnych, jak i typowo leśnych, w obu analizowanych siedliskowych typach lasu. Większy związek pomiędzy rozpatrywanymi właściwościami stwierdzono dla gruntów typowo leśnych (Bśw r = 0,93; BMśw r = 0,88), mniejszy zaś dla gleb porolnych (Bśw r = 0,48; BMśw r = 0,42). Drewno twardzielowe sosen wyrosłych na gruntach porolnych w warunkach siedliskowego typu lasu BMśw wykazywało odmienne właściwości. Drewno to, o dużej gęstości, charakteryzowało się małą wytrzymałością na ściskanie wzdłuż włókien. Drewno pochodzące z drzew wyrosłych w warunkach porolnych nie wykazywało różnic w budowie makrostrukturalnej w porównaniu z drewnem pochodzącym z siedlisk leśnych.

Słowa kluczowe: gęstość umowna, wytrzymałość na ściskanie wzdłuż włókien, sosna zwyczajna, grunty porolne, grunty leśne

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