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Compression strength of pine wood (Pinus Sylvestris L.) from selected forest regions in Poland, part II

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Abstract: *Compression strength of pine wood (Pinus Sylvestris L.) from selected forest regions in Poland, part II.* Article presents compression strength of pine wood originating from two different regions. Tests showed non-uniformity of properties of wood originating from single natural region . Highest uniformity of obtained results was shown by sawn timber originating from Baltic Region.

Keywords: pine wood, mechanical properties, major axis compression strength

INTRODUCTION

Shear strength is popular indicator of mechanical properties of wood. It is highly correlated with other mechanical properties, such as bending strength, modulus of elasticity and density (Kollmann, Côte 1984). Compression strength testing is much easier in application than bending strength or modulus of elasticity tests. Testing may be done on small defect-free samples (in accordance to PN-77/D-04102 standard) or on large samples cut out of timber (e.g. structural), made by slicing whole cross-section of the board. Third dimension, along the grain is then six times longer than shorter side of the cross section (according to PN-EN 408 standard). Following work presents compression strength tests of pine wood coming from two Polish forest regions. It is pioneer research, introducing larger work including not only geographical origin of the wood, but also quality of timber used for evaluation. Samples will be cut out of timber classified into strength and quality grades basing on the visual and machine grading methods. This supplementary tests are planned performed on Faculty of Wood Technology (Krzosek 2009).

METHOD AND TEST MATERIAL

Following work is continuation of research made and published in 2011 (Mańkowski et all. 2011). Tests made in 2011 dealt with timber doming from Masuria-Podlachia PL, Greater Poland-Pomerania PL and Carpathia PL regions. Actually presented tests were made on timber originating from two other regions, not included in previous tests (Krzosek 2009): z Baltic Region and Lesser Poland Region. As previously, 2 boards from each region were selected for tests. Basing on the previous tests (Krzosek 2009), timber selection consisted of various quality grades. Again, like in 2011 (Mańkowski et all. 2011), from each board 100 compression strength samples were cut out, of 20x20x30 mm dimensions (last dimension was in major axis, along the grain). Only 50 samples from each board were selected for testing, those with growth rings not parallel to sides were rejected. Timber before cutting samples was conditioned in laboratory conditions ($t=20^oC$, $\varphi=40\%$).
In total 200 samples were tested, 100 from each region (coming from the single board), Before strength testing, density of the samples was measured with stereometric method in accordance to PN-77/D-04101 standard.

For wood density determination VIS caliper (0.01mm accuracy) and Sartorius scales of 0,001g accuracy were used.

For compression strength determination 50 KN Instron testing machine was used.

RESULTS AND ANALYSIS

Table 1 presents density measurements, table 2 compressive strength in major axis, regarding origin of the wood.

Table 1. Density of tested timber

		Region					
	unit	Balic			Lesser Poland		
Number of test boards	-	372	352	average	140	182	average
Number of measurements	-	50	50		50	50	
Min	g/cm^3	0,404	0,447	0,426	0,357	0,393	0,375
Avg	g/cm^3	0,434	0,541	0,488	0,422	0,454	0,438
Max	g/cm^3	0,544	0,582	0,563	0,500	0,522	0,511
Standard deviation	g/cm^3	0,03	0,04	0,035	0,03	0,04	0,035
Variation coefficient	%	0,06	0,07	0,065	0,06	0,08	0,070

Average density of pine samples originating from Baltic Region reached 0,487 g/cm^3, samples coming from Lesser Poland region averaged at 0,438 g/cm^3. Highest variation of density of samples coming from single area was noticed for timber originating from Baltic Region – equaling 0,107 g/cm^3, in case of samples from Lesser Poland region variation reached 0,032 g/cm^3. Baltic region timber proved to be less homogenous density-wise. For all tested batch (timber from all 5 tested regions) timber from Baltic Region reached highest average density measured on small-sized samples cut-out from 2 boards, again samples from Lesser Poland showed lowest average density.

Table 2. Compressive strength in major axis

		Region					
	unit	Balic			Lesser Poland		
Number of test boards	-	372	352	average	140	182	average
Number of measurements	-	50	50		50	49	
Min	MPa	43	51	47,0	36	48	42,0
Avg	MPa	50	69	59,5	48	55	51,5
Max	MPa	58	81	69,5	57	64	60,5
Standard deviation	MPa	2,73	9,01	5,87	6,77	3,35	5,06
Variation coefficient	%	0,05	0,13	0,09	0,12	0,06	0,09

Average compressive strength of samples from Baltic Region averaged 59,5 MPa, samples originating from Lesser Poland region reached 51,5 MPa. Highest variation in compressive strength between samples coming from the single region was observed in timber originating from Baltic Region - 19 MPa, in case of samples from Lesser Poland region variation reached 7 MPa. For whole tested timber batch (originating from all 5 regions), samples from Lesser Poland region had lowest average compressive strength: 51,5 MPa.

Aiming at deeper analysis of obtained results correlation between density and compressive strength was calculated (tab. 3)

Table 3. Density/strength correlation in tested timbers.

Series from timber no.	Region	Density/strength correlation	Correlation for single region
372	Baltic	0,400	0,892
352		0,957	
140	Lesser Poland	0,909	0,827
182		0,850	

Correlation between density of wood and its compressive strength in major axis for samples originating from Baltic Region reached 0,89. Correlation coefficient between density and compressive strength in test board number 372 is low (0,400) and definitely varies from coefficient reached by board number 352 (0,957), originating from the same region. High correlation coefficient for board number 352 roughly reflects properties of wood originating from Baltic Region . Density of the board number 372 definitely varies from the other boards from this area. Basing on the previously made testing results, density of the board no. № 372 reached 0,434g/cm^3 and for board № 352 - 0,556 g/cm^3 (Krzosek 2009). For timber originating from Lesser Poland area, variation coefficient equaled 0,83.

Figure 1 presents dependence of compressive strength in major axis against wood density, separately for each tested board. It shows, that density of wood, even coming from the same region is highly variable. Highest density (as well as highest compressive strength) is shown by board № 352 from Baltic Region. Lowest density is represented by board № 140 originating from Lesser Poland Region.
Measured density values conform to literature-given ranges [Krzysik 1974], from 0,33 g/cm^3 up to 0,89 g/cm^3. Only samples cut out of board № 352 show density values higher than average (0,520g/cm^3).

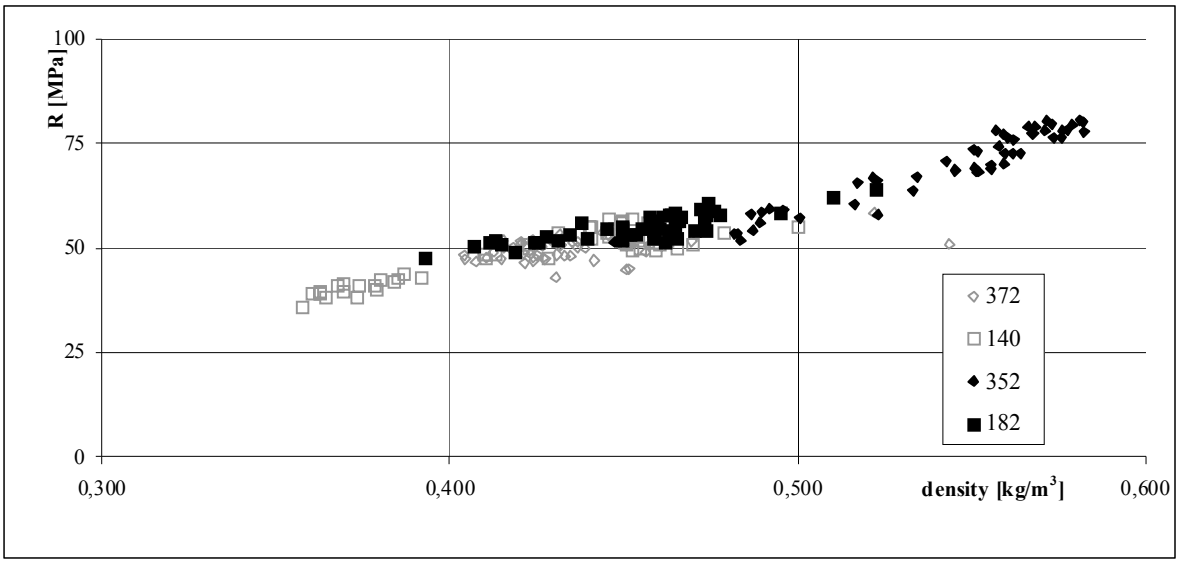

Figure 1. Relation between density and compressive strength in major axis for each tested board.

Figure 2 presents the same relation for tested regions, not separated into single boards.

High correlation coefficient between density and compressive strength was acquired. Wood originating from Baltic Region reaches higher density, strength and correlation values. All

samples from Lesser Poland region show density values lower than given by literature [Krzysik 1974].

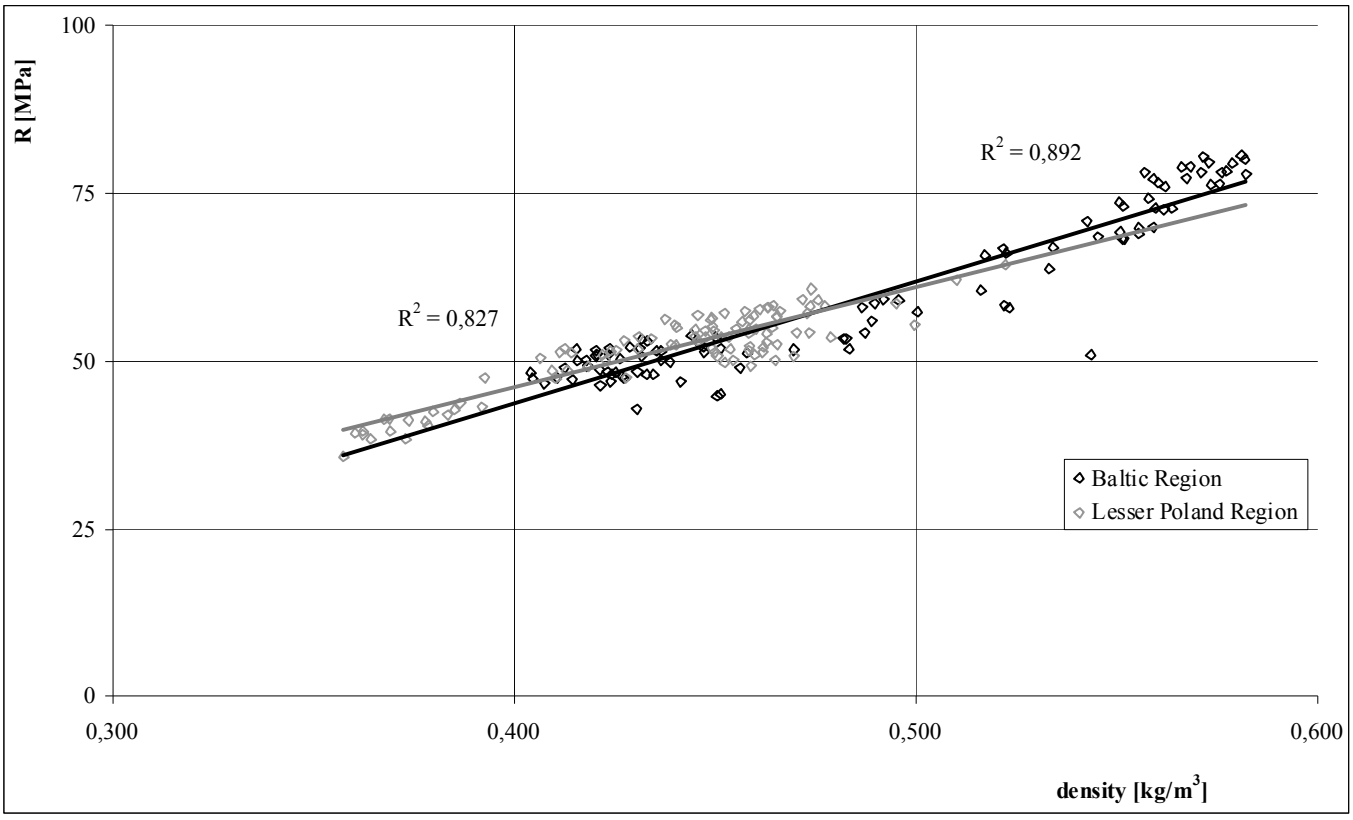

Fig. 2. Relation between density and compressive strength in major axis for wood originating from both tested regions.

CONCLUSION

Basing on the obtained results, one may conclude:
1. Tested timber originating from separate regions has similar properties.
2. Wood originating from Baltic Region had higher mechanical properties.
3. Wood originating from Lesser Poland Region had lower mechanical properties.

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7. PN-79/D-04102 Drewno. Oznaczanie wytrzymałości na ściskanie wzdłuż włókien.

Streszczenie: *Wytrzymałość na ściskanie drewna sosnowego pochodzącego z różnych krain przyrodniczo leśnych Polski, cz II.* W referacie przedstawiono wyniki badania wytrzymałości na ściskanie wzdłuż włókien drewna sosnowego pobranego z tarcicy pochodzącej z dwóch różnych krain przyrodniczo leśnych. Badania wykazały niejednorodność badanych właściwości drewna pochodzącego z tej samej krainy przyrodniczo leśnej. Największą jednorodnością badanych właściwości wykazała się tarcica pochodząca z Bałtyckiej Krainy Przyrodniczo Leśnej.

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