

## **Compression strength of pine wood (*Pinus Sylvestris* L.) from selected forest regions in Poland**

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**Abstract:** Compression strength of pine wood cut in three different areas was measured. Test showed high variation of measured parameters of wood coming from various areas and even of these coming from same area. Best uniformity was shown by timber coming from Wielkopolska - Pomerania areas.

*keywords:* pine wood, mechanical properties, 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, 1978). Compression strength testing is much easier to perform 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 by slicing whole cross-section. Third dimension, along the grain is 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 three forest areas in Poland. It is introductory research, part of the larger work including not only geographical origin, 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 methods. This will become supplementary tests performed on Faculty of Wood Technology (Krzosek 2009).

### METHODIC AND TEST MATERIAL

Two pieces of timber were used for tests, coming from following areas: Masuria-Podlasie PL region, Wielkopolska-Pomerania PL region and Carpathia PL region. Basing on the previous research (Krzosek 2009) various grades of timber was selected. Each piece was cut into 100 samples for compression test along the grain. For testing 50 pieces from each batch was chosen, discarding these with annual rings not parallel to one of the sample's sides. Timber before cutting into samples was seasoned in laboratory conditions ( $t=20^{\circ}\text{C}$ ,  $\varphi=40\%$ ). 300 samples, for 100 from each tested region (cut out of two selected timber pieces), were used for research. Before compression strength tests density of the samples was determined, using stereometric method in accordance to PN-77/D-04101.

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

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

### RESULTS AND ANALYSIS

Table 1 shows density measurement results, Table 2 compression strength along the grain of pine wood in dependence on the origin area.

Table 1. Density test

	unit	Forest region								
		Carpathia			Masuria-Podlasie			Wielkopolska Pomerania		
Timber batch quantity	-	95	76	śr	702	726	śr	260	296	śr
Number of measurements	-	50	50	100	50	50	100	50	50	100
min	g/cm <sup>3</sup>	0,368	0,416	0,368	0,393	0,380	0,380	0,427	0,411	0,411
max	g/cm <sup>3</sup>	0,459	0,519	0,519	0,542	0,535	0,542	0,501	0,525	0,525
average	g/cm <sup>3</sup>	0,415	0,463	0,439	0,473	0,469	0,471	0,463	0,483	0,473
Standard deviation	g/cm <sup>3</sup>	0,02	0,03	0,034	0,02	0,031	0,035	0,02	0,02	0,025
Variation coefficient	%	5	6	8	5	7	8	5	5	5

Average density of all samples cut out of Carpathian region timber reached 439 kg/m<sup>3</sup>, from Masuria-Podlasie – 471 kg/m<sup>3</sup> and from Wielkopolska- 473 kg/m<sup>3</sup>. Greatest differences between the samples from single tested region were observed for Carpathian timber.

Table 2. Compression strength along the grain

	unit	Forest region								
		Carpathia			Masuria-Podlasie			Wielkopolska Pomerania		
Timber batch quantity	-	95	76	śr	702	726	śr	260	296	śr
Number of measurements	-	49	49	98	49	50	99	50	49	99
min	MPa	45	44	44	43	48	43	53	51	51
max	MPa	67	64	67	77	74	77	69	74	74
average	MPa	55	54	55	64	64	64	62	67	64
Standard deviation	MPa	4,90	4,37	5	7,96	5,86	7	4,79	5,14	5
Variation coefficient	%	9	8	9	5	9	11	8	8	8

Average compression strength of all samples cut out of Carpathian region timber reached 55 MPa, for samples cut out of timber coming from remaining two regions, compression strength equaled 64 MPa. Highest differences in compression strength averages along the grain between samples coming from the single region were observed for Wielkopolska-Pomerania timber.

In aim to deepen analysis level of the obtained results, correlation between compression strength and density values was calculated (table 3)

Table 3. Density/strength correlation for tested timber

Sample series from timber No	Forest region	Density/strength correlation	Correlation for region
260	Wielkopolska-Pomerania	0,91	0,94
296		0,84	
702	Masuria-Podlasie	0,91	0,82
726		0,93	
95	Carpathia	0,78	0,34
76		0,18	

Correlation between density and compression strength along the grain was highest (0,94) for timber originating from Wielkopolska-Pomerania region. For Masuria-Podlasie region,

coefficient was lower, at 0,84 level. Lowest correlation coefficient showed up in timber from Carpathia region. Extremely low value (0,34) of correlation in samples from Carpathia region can be justified by high resin content, especially in one timber piece, so in samples cut out of fit as well. Resin density exceeded density of wood, but did not alter compression strength, so almost no correlation showed up as a (correlation coefficient 0,18) for samples cut out of timber piece number 76.

Figure 1 shows dependency of compression strength of tested pine wood samples and their density. It is necessary to remark, that high batch variation was show not only by low quality timber coming from Carpathia region, but also much better timber of Masuria-Podlasie region origin.

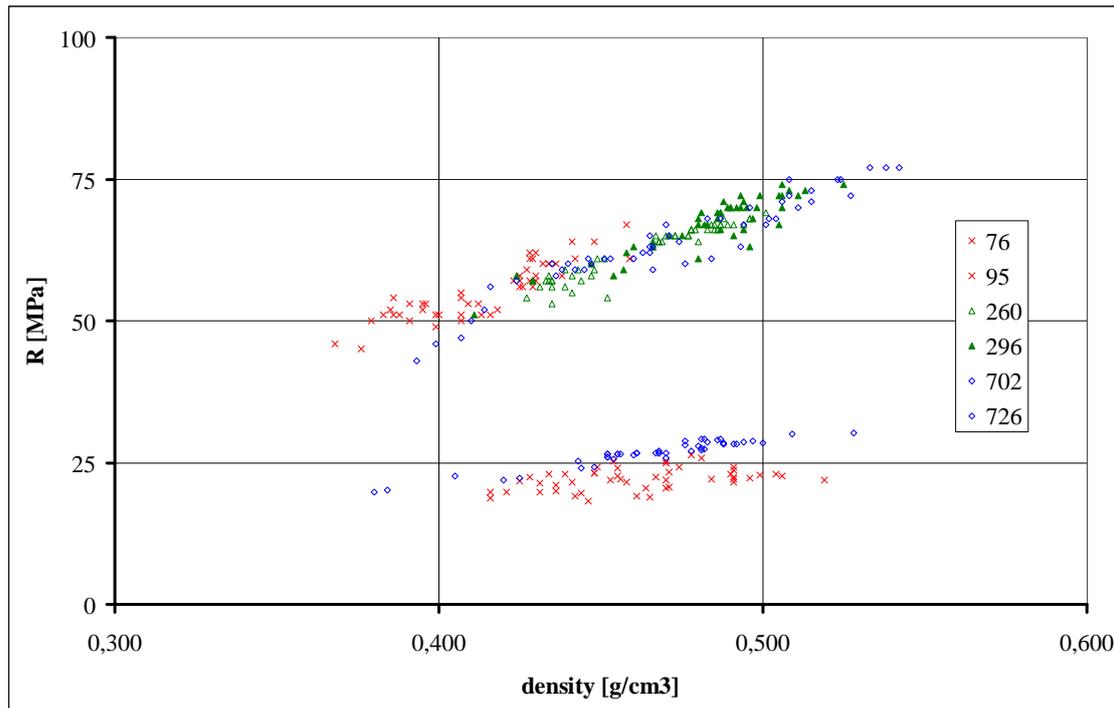


Fig 1. Dependenci between density and compression strength tested along the grain.

Only samples cut out of two timbers (no. 260 and 296) originating from Wielkopolska-Pomerania region were uniform set. Samples cut out od timbers of remaining regions created sets with great diffusion in tested properties (no. 76 and 95 from Carpathia region and 702 and 726 from Masuria-Podlasie region ).

## CONCLUSION

1. Basing on the performed tests , one may conclude that testing on small samples confirmed results gained by testing full-size timber. Samples cut out of timber coming from Carpathia region showed lowest average density and lowest average compression strength.
2. High variation of tested samples was shown not only by low quality timber doming from Carpathia region, but also much better quality timber of Masuria-Podlasie region.

## REFERENCES

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

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