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Glued elements for construction

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Abstract: G*lued elements for skeletal construction*. Qualities of won design elements in research from production of wood construction definite pine timber Work included comparison of specificity resistance and with reference to proper objective norms with taking into consideration dimension partition of semi-finished article qualitative raw material. The study of mechanical properties of the samples included the determination.

Keywords: wood, quality classification , glue timber products

INTRODUCTION

The objective of investigations is to determine the quality of structural elements manufactured from sawn pinewood for the production of wooden constructions. The scope of investigations comprises comparison of strength and quality properties of pinewood raw material taking into consideration the origin and dimensional intervals of semi-finished products (Buchholz 1975, Buchholz J., Hruzik. 1970, 1973, Dziewanowski 1965, Hruzik 1979).

The performed experiments will allow collecting data concerning strength parameters as well as suitability of sawn materials for production purposes improved by elimination of defects and gluing.

METHODOLOGY AND RESEARCH RESULTS

A total of 75 glue pine samples were prepared for purposes of this experiment. They were allocated into groups which differed regarding the applied glue and cross-section. The experimental samples were obtained using three different glues employed in the production of building glued materials.

- The samples were glued using the following glue JOWACOLL 102 20 – pine A
- The samples were glued using the following glue AKZO NOBEL EPI 8055 - pine B

To compare static bending strength, solid samples constituting the initial material for the production of layers of glued semi-finished elements were prepared.

During the performed experiments, in order to determine basic features of pine wood for purposes of experiments, such physical properties as: annual increment, proportion of late and early wood in annual increments, density as well as absolute moisture were determined.

The results obtained in the course of the performed experiments revealed that the material obtained from glued pine timber was characterized by the density of 520 kg/m^3. Layers of glued pine samples were characterized by densities in the range of 490 kg/m^3 to 557 kg/m^3. When interpreting density results in relation to the position of the examined samples in the large-sized sample it can be concluded that the timber material used to manufacture glued elements did not have similar properties.

The next physical property affecting pinewood quality and usefulness is structure of annual rings. According to earlier investigations (Kollmann), narrow annual rings in coniferous timber indicate higher quality parameters (Krzysik 1978).. The largest mean width of annual rings of battens (2.01 mm) was recorded for construction elements of sample B of 40 x 96 mm cross section. The smallest mean width of annual rings of battens (1.68 mm) was recorded for construction elements of sample B of 40 x 72 mm cross section.

This may have exerted some influence on the observed negative strain distribution in the course of mechanical loading and may have caused wood warping following different desorption strains in the neighboring layers of the element. The minimal measured annual width increment in pine wood amounted to 0.30 mm, whereas the maximal one – up to 5,30 mm.

The obtained research results confirmed significant variations in widths of annual increments in neighboring layers. Increment widths in relation to the layer of sample origin and averaged results of all samples from a given batch were itemized and the difference in ring distribution/graining was apparent. So, in the case of glued pine timber, the mean width of annual increments ranged from 1,90 mm to 1,96 mm in group "A" and from 1,68 mm to 2,01 mm in group "B".

Static bending strength for model solid samples

For comparative purposes of the raw material, in the performed investigations, solid samples in accordance with the PN-77/D-4103 standard were obtained. Laboratory samples (free of defects) are characterized by greater strength than large-sized samples. Table 1 presents sample strengths obtained for samples from A and B raw material recorded at static bending.

Tab.1 Static bending strength of model samples of A and B samples (Source: own research, Michnowicz 2008)

	"A" R_{g12} (MPa)			**"B" R_{g12} (MPa)**		
Zone	Min	Average	Max	Min	Average	Max
compressed zone	53	77	97	49	71	90
central zone	51	66	90	53	59	85
stretched zone	50	81	97	47	79	93

Samples characterized by the lowest mean strength (66 and 59 MPa) were obtained from central battens of both A and B samples of the construction elements. The highest mean strength (81 and 79 MPa) was recorded for samples obtained from extended zones of battens also of samples A and B of construction elements. The highest strength value recorded for a single sample amounted to 97 MPa and the lowest – to 47 MPa. Mean differences between the obtained results for group A and B were contained in the interval of about 2.5 to 10.5%. Analyzing strength differences for the raw material used for external and central layers, the strength for samples from compressed layers was found to be, on average, by about 14-16% higher, while the strength for samples from the bottom, extended layers was by about 23-34% higher, which confirms the appropriate selection of the raw material for the production of large-sized elements.

Static bending strength for large-sized samples

Static bending strength is one of the most frequently applied strength tests which exert a direct impact on designing of wooden constructions (Dzbeński., Kozakiewicz, Krzosek

2005). Static bending strength was determined for large-sized samples in accordance with methodological assumptions and the obtained results are presented in Table 2.

Tab 2 Static bending strength of large-sized samples of A and B samples (Source: own research, Michnowicz 2008)

Cross section (mm)	**"A" R_{g15} (MPa)**			**"B" R_{g15} (MPa)**		
	Min	Average	Max	Min	Average	Max
40x72	25	39	48	23	40	55
40x100	24	35	55	23	36	50
40x120	27	29	31	26	34	45

Construction elements 72 mm wide showed the highest mean strength (39 and 40 MPa). Semi-finished products 120 mm wide obtained lowest mean strengths (29 and 34 MPa). The lowest strength value (23 MPa) was recorded for the samples with 40 x 72 mm (B) and 40 x 96 mm (B) cross sections, while the highest (55 MPa) - samples with 40 x 100 mm (A) and 40 x 120 mm (B) cross sections. Mean differences between the obtained results for groups A and B in dimensional intervals of 40 x 72 and 40 x 100 mm cross sections were contained in the interval of about 2.5% mm in favour of beams of group B, while for the 40 x 120 mm cross section reached the difference of about 17%. Analyzing the results of strength for beams from group A, the obtained mean discrepancy was at the level of about 10-25% and for beams from group B – from about 6% to about 15%. Higher results were found for beams of a smaller height dimension.

Comparing the obtained strength results for large-sized beams with the results obtained on laboratory samples, it can be said that the results for the large-sized glued elements, both in group A and B, were by about 47-54% higher in comparison with the model.

Part of low bending strength values of construction elements could be blamed on the delamination of the lap-joints. The most frequent place of such horizontal separation was the glue-line area of the connection.

Research results presented in Table 3 characterize the strength according to the PN-EN 338 standard "Construction wood. Strength classes" where the bending strength is adopted as a criterion.

Tab.3 Detailed presentation of strength classes (Source: own research, Michnowicz 2008)

strength classes:	sign samples:					
	A 40x72	A 40x100	A40x120	B 40x72	B 40x100	B 40x120
C14	Meets	Meets	Meets	Meets	Meets	Meets
C16	Meets	Meets	Meets	Meets	Meets	Meets
C18	Meets	Meets	Meets	Meets	Meets	Meets
C22	Meets	Meets	Meets	Meets	Meets	Meets
C24	Meets	Meets	Meets	-		Meets
C27			Meets	-		
C30				-		

C35				-		
C40				-		

legend:

Meets – the lot meets the standards

The results of classification shown in Figure 3 illustrate in a simple way that, according to the PN-EN 338 standard, the examined large-sized samples achieved different strength classes. It can be said that the examined wood raw material attained the strength class on the level C16-C18. According to the presented classification, there were no significant differences in the pine raw material glued with the applied resins.

According to the standard, the results of mean bending strength of laboratory samples attained the highest strength class C40 for sample series. However, the final classification belongs to the lowest results of fulfillment of the strength standard.

RECAPITULATION

The following conclusions were drawn on the basis of the performed investigations and measurements and the obtained results:

1. The determined width of annual rings of the coniferous timber intended for the production of semi-finished articles was contained within 0.3 to 5.3 mm interval with the mean value of about 2 mm. So the examined raw material can be classified as narrow-ringed. Mean densities of pinewood battens used for the production of semi-finished articles are contained within the 520-542 kg/m^3 interval and are higher in comparison with those given by Kollmann (490 kg/m^3).
2. Empirically determined static bending strength for solid model samples from pinewood raw material reached the following values: minimal - 47 MPa and maximal - 97 MPa. The mean strength for the individual zones was contained within the 59-81 MPa interval. The results obtained for the examined samples are lower than the static bending strength for pinewood which, according to Wanin amounts to 87 MPa, and to Göhre - 88 MPa.
3. The obtained results of static bending strength of semi-product (Fm,g,k = 19MPa) compared with data PN-EN 1194 are too low to give a class of endurance for the semi-product.
4. Low values of static bending strength, to a considerable extent, can be attributed to displacements at the contact of the glue-line both at multi-wedge and layer joints. It is worth noticing the disordered arrangement of glued battens - from radial to tangential - which could have contributed to the decrease of strength parameters in the examined samples.

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12. PN-EN 1194 Konstrukcje drewniane -- Drewno klejone warstwowo -- Klasy wytrzymałości i określenie wartości charakterystycznych

Streszczenie: *Elementy klejone dla budownictwa szkieletowego.*
W badaniach określono jakości obejmowało określenie pozyskiwanych elementów konstrukcyjnych z tarcicy sosnowej do produkcji konstrukcji drewnianych. Praca obejmowała porównanie właściwości wytrzymałościowych i jakościowych surowca w odniesieniu do właściwych norm przedmiotowych z uwzględnieniem przedziałów wymiarowych półfabrykatów. Badanie właściwości mechanicznych próbek wielkogabarytowych.

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Application of gas-steam mixture for wood drying purposes

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Abstract: *Application of gas-steam mixture for wood drying purposes.* The high cost of fossil fuel and soaring interest rates have encouraged people in the wood industry to look for faster and more energy-efficient methods to dry lumber. In this paper results of experimental study of flow pattern and heat transfer during application of gas-steam mixture for wood drying purposes are presented. Wood species, namely oak (Quercus L.) and pine (Pinus L.), were subject of steam drying process in a laboratory kiln especially arranged for that reason. Main focus of those tests was to shorten the time of drying process and afterward to check properties of wood. As results of mechanical properties checking are presented in separate paper, here authors focused on numerical predictions of uniform velocity and temperature profiles through the drying kiln, which is of great importance for drying and also for energy saving. Predicted velocities were used in the laboratory kiln for tests. Satisfactory results were obtained as the time of drying process was significantly reduced.

Keywords: wood drying, high-temperature drying, steam drying

INTRODUCTION

The dynamic development of the economy following Polish accession to the European Union has not circumvented the wood industry. Thanks to the development of the wood drying techniques using saturated or superheated steam flows and gas-steam mixtures, waiting time for wood material for the furniture industry will be reduced. Wood drying in addition to the technical importance brings economic benefits, such as protection of wood against fungi and fracture, which extends its life, facilitates machining and surface finishing of wood, fast drying (e.g. steam) improves the balance of wood, and brings savings in transport costs by reducing the weight of wood . The wood that has too high water content is not useful for the production of furniture. Changes in size and shape, occurring in the wood during the evaporation of water will affect the quality and dimensions of the furniture. The resistance to weather conditions is also higher.

EXPERIMENTAL BACKGROUND

Drying in superheated steam is economically justified because of the shorter processing time and reduced energy consumption, while it is, in this respect, better than drying in hot air. In the absence of oxygen there is no oxidation processes in the wood (although high-temperature of medium) and the danger of fire is excluded. Short drying time, lower energy consumption and high quality of wood after drying in an atmosphere of superheated steam are in favour of the use of this method in industrial practice [1].