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Evaluation of pine raw material for construction using visual classification

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Abstract: *Evaluation of pine raw material for construction using visual classification.* In this paper are presented the results of comparative research of structure wood sorted by visual methods and strength examinations. The pine wood from the vicinity of Sulechowo was used for the research. Physical properties of wood (density, moisture content and annular growth rings) and mechanical properties (module of elasticity) were tested. The samples, divided into quality classes, were subjected to visual evaluation. The results of the evaluation were compared with the results of tests carried out on universal testing machine.

Keywords: wood, glue timber, construction wood.

INTRODUCTION

Due to high requirements concerning construction wood, producers are obliged to precisely control and select the raw material used in wooden constructions. These materials must comply with the requirements set by the norms concerning building timber.

Sawn timber to be used in the construction, should be sorted with respect to its endurance. Being aware of loads affecting specific construction it is possible to select wood of appropriate strength class which will provide the structure with appropriate safety and the endurance.

Two wood sorting methods are applied: visual and machine, both are non-destructive. Poland adopted the norm PN-EN 14081 which consists of four parts and replaced the two previous norms: PN-EN 518, and PN-EN 519. First part of the norm PN-EN 14081 is describing principles of visual sorting. In Poland there are many applicable norms concerning solid structural lumber as well as laminated lumber among them: PN-EN 384; PN-EN 14080; PN-EN 408; PN-EN 1194; PN-EN 942; PN-EN 336; PN-EN 338.Properties determined at endurance examinations, allow for assigning endurance classes from C14, to C50.

Sorting using visual method in Poland is carried out according to the PN-82 ⁄ D-94021 norm:

"Structural coniferous timber sorted applying endurance methods". This norm divides material into 3 quality classes (PN-82 ⁄ D-94021, Grześkiewicz and Krzosek 2005, Krzosek 2009):

This norm relates to the norm: PN-EN 1912: 2007 - "Structural wood -endurance classes- visual division into classes and types". This norm combines assigned sorting classes from PN-82 / D-94021 with strength C classes.

The aim of this research was to carry out the analysis in a form of study of structural timber using visual and endurance methods (Wieruszewski and Gotych 2011, Wieruszewski and others 2011). It has been decided to use pine raw material for the purpose of this study as it is the type of material most commonly used in construction.

METHODOLOGY AND THE DESCRIPTION OF THE STUDY

Wood used for endurance tests came from the forest district Sulechów in Lubuskie Province, forestry Stary Dwór, branch: 255b.

Samples of solid wood selected for tests measured about 40x150x2400mm were obtained from logs of different diameters and the plywood of the same dimensions. The arrangement used in saws coupling facilitated obtaining elements that had fibers with radial, tangent and parallel arrangement. Additionally, the authors tried to obtain samples with radial fibers arrangement containing the core. Samples with radial arrangement of fibers were obtained from central part of the log, but tangents and parallels were extracted from external log parts. Following describing samples they were transferred into drying room, where they stayed until the required humidity was obtained. The next stage was whittling process so that finally solid elements were trimmed to the required length. As the result of these operations 63 solid elements came into existence.

Visual sorting was conducted according to the Polish PN-82 norm / D-94021. Material was subject to a thorough evaluation of its features and then an appropriate strength class was assigned to it. Visual sorting is often flawed since individual pieces are often graded one class below their actual quality.(Dzbeński and others 2005, Grześkiewicz and Krzosek 2005, Krzosek 2009). The endurance sorting was conducted based on the module of elasticity, being one of endurance important indicators in non-destructive testing. An endurance ZDM 2214 machine was used during tests. Thrusts were located 750 mm from each other, the props were 2250 mm apart. The measurement of deflection was conducted using attached sensor deflectometer (accuracy 0.01 mm). The load was adjusted to reach 10 kN, the measurements indicated by moving tip were recorded with the increase in power of every 500 N.

The module of elasticity at static bending was being calculated according to the formula:

$$E_{gW} = \frac{a * l^2 * (P_2 - P_1)}{16 * b * h^3 * (f_2 - f_1)}$$

where:

P_2 – loading of a given range [N],
P_1 – initial loading [N],
l – distance between props [mm],
f_2 – deflection at loading a given range [mm],
f_1 – deflection imposed by initial loading [mm],
b – sample width [mm],
h – sample height [mm],
a- distance between prop and thrust.

Calculating elasticity coefficient at static bending of a sample of real moisture content „W" [%] onto the elasticity coefficient of a sample of moisture content W=12%.

DATA COLLECTION AND ANALYSIS OF TESTS RESULTS

Density is one of the basic physical features of wood. The analysis suggests that average density for all samples amounted to 502,8 kg/m^3. Logs density ranged from 455,8 kg/m^3, for the row material obtained from log number six to 593,3 kg/m^3 for the material obtained from log number 7.

Moisture content of the dried samples from various logs ranged from 7,67% to 10,23%. Mean value of moisture content of all samples equalled 8,66%.

Elasticity module is one of the main features according to which construction sawn wood is classified. The results of tests carried out on endurance machine were presented in figure 1 - 2.

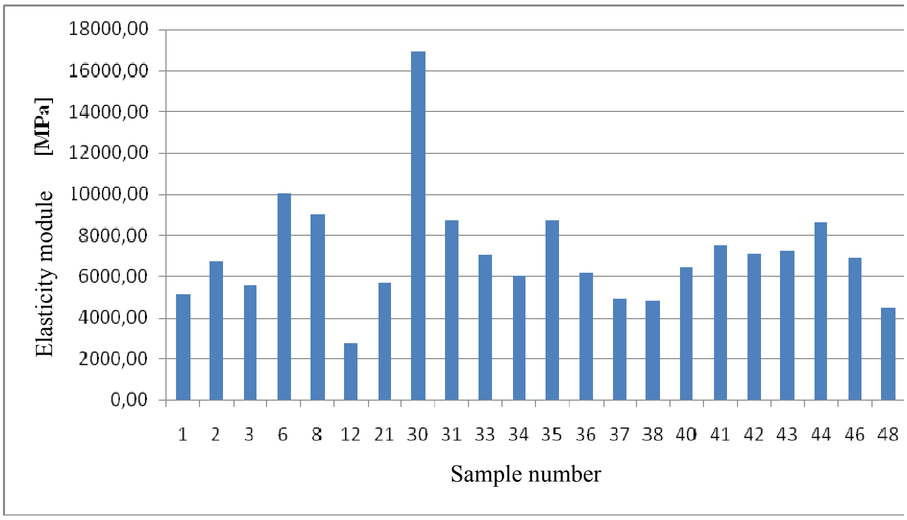

Fig. 1 Module of elasticity for samples with radial arrangement of fibers

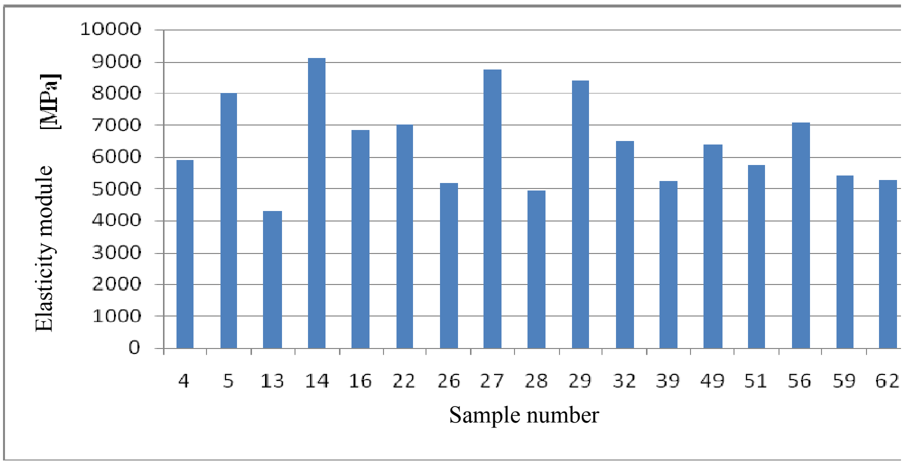

Fig. 2 Module of elasticity for samples with radial arrangement of fibers and the core

As it has been shown in figure 1 there were 21 samples with a radial arrangement of fibers. Module of elasticity oscillated from 2774,5 MPa to 16935 MPa. The average for all of these samples was 7114,97 MPa.

The data in figure 2 shows that the number of tested samples with radial arrangement of fibers containing the core was 16. The module of elasticity of these samples ranged from 4299.65 MPa to 9121.66 MPa. The average for these samples was 6473.45 MPa

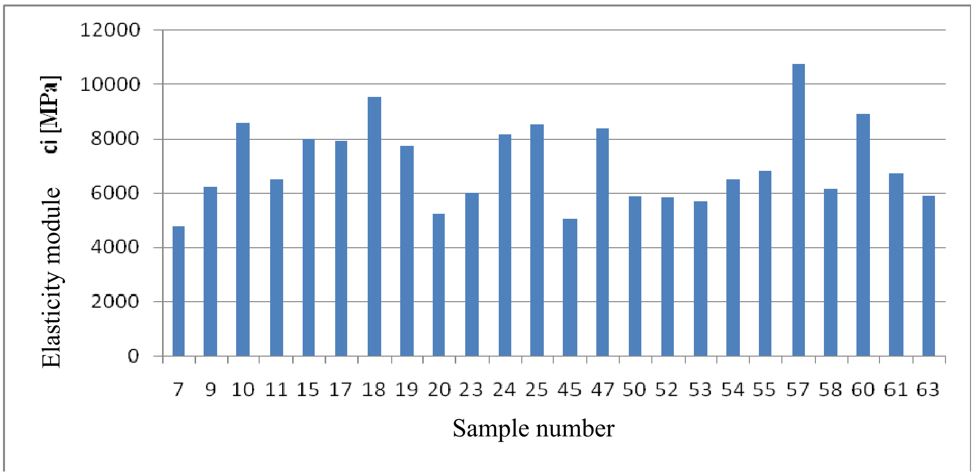

Fig.3 Module of elasticity for samples with tangent arrangement of fibers

Figure 3 shows that there were 23 tested samples with tangent fibers arrangement. The module of elasticity fluctuated from 4761.58 MPa to 10731.45 MPa. The average for all these samples was 7068.15 MPa

Analyzing the results it can be stated that the highest average elasticity module was characteristic for samples with radial arrangement of fibers: 7114,97 MPa, it was lower for samples with tangent fibers: 7068,15 MPa, and the lowest for samples with radial fibers with the core.6473,45 MPa.

As the result of visual sorting of solid samples into the following quality classes : KW, KS, KG the results presented in figure 4 were obtained.

As it can be read from the figure below as the result of visual sorting 14 samples were allocated to class KW, 27 samples were allocated to class KS, and 22 samples to class KG.

Tab. 1 Allocating endurance tested samples to quality class C

Sample number	quality class	sample number	quality class	sample number	quality class
1	C14	22	C18	43	C18
2	C18	23	C18	44	C30
3	C14	24	C30	45	C14
4	C18	25	C30	46	C18
5	C27	26	C14	47	C30
6	C30	27	C30	48	-
7	C14	28	C14	49	C18
8	C30	29	C30	50	C14
9	C18	30	C30	51	C14
10	C30	31	C30	52	C14
11	C18	32	C18	53	C14
12	-	33	C18	54	C18
13	-	34	C18	55	C18
14	C30	35	C30	56	C18
15	C27	36	C18	57	C30
16	C18	37	C14	58	C18
17	C27	38	C14	59	C14
18	C30	39	C14	60	C30
19	C27	40	C18	61	C18
20	C14	41	C18	62	C14
21	C14	42	C18	63	C14

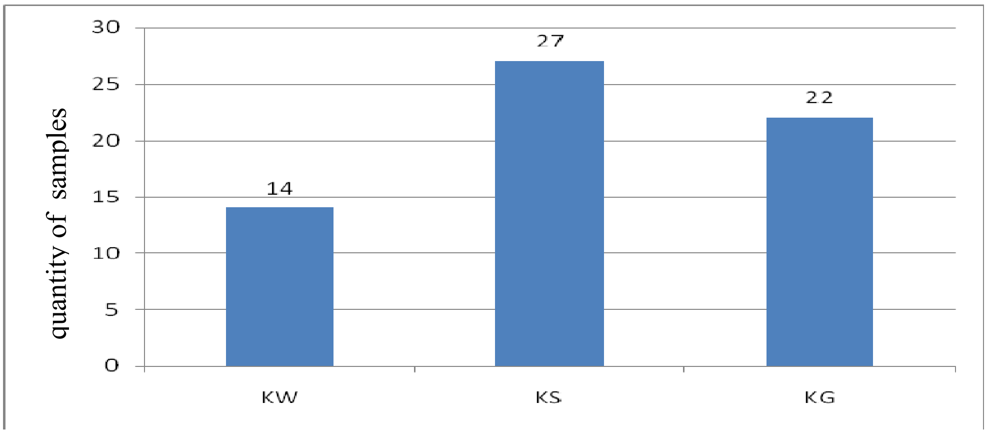

Fig.4 Visually sorted solid samples

As the data presented in table 1 shows, 19 samples were classified as C14, 21 samples as C18, 5 samples as C24, and 16 as C30.

Quality classes of visually sorted wood: KW, KS, KG correspond to the following classes of machine sorted wood: C18, C24, C30. Comparing the results it can be stated that there is a large discrepancy in sorting systems. Endurance test method classified 3 more samples as KW, 13 fewer samples as KS and 21 more samples below grade KG (C14 and 3 rejected) in comparison with the application of visual sorting method.

CONCLUSIONS

The comparative study of sorting construction solid and glued materials using both visual and endurance test methods allows the authors to draw the following conclusions:

1. Elasticity module for solid samples amounted on average to 6924,02 MPa. The highest result was obtained by log number 30 - 16935 MPa, and the lowest by log number 12 - 2774,5 MPa.
2. For samples with radial arrangement of fibers elasticity module ranged from 2774,5 MPa to 16935 MPa. Mean value for all such samples was 7114,97 MPa. Elasticity module of samples with radial arrangement of fibers with the core ranged from 4299,65 MPa to 9121,66 MPa. Average result for those samples amounted to 6473,45 MPa. Elasticity module of samples with tangent arrangement of fibers ranged from 4761,58 MPa to 10731,45 MPa. Average result for all those samples was 7068,15 MPa.
3. As the result of visual sorting 14 samples were classified as KW, 27 samples as KS, and 22 samples as KG. Following allocating machine tested 19 samples were classified as C14, 21 samples as C18, 5 samples as C24, and 16 as C30.
4. Comparing visual and endurance methods one may see a substantial discrepancy in the obtained results.

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Streszczenie: *Ocena sosnowego drewna konstrukcyjnego metodą wizualną.* W pracy przedstawiono wyniki badań porównawczych drewna konstrukcyjnego sortowanego metodami wizualnymi i wytrzymałościowymi. Do badań wykorzystano drewno sosny pochodzące z okolic Sulechowa. Zostały przeprowadzone zarówno badania właściwości fizycznych drewna, takich jak gęstość, wilgotność i słoistość oraz właściwości mechanicznych takich jak moduł sprężystości. Przeprowadzono ocenę wizualną próbek z podziałem na klasy jakości, a uzyskane wyniki porównano z wynikami uzyskanymi na maszynie wytrzymałościowej.

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