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QUALITY OF CEDRUS ATLANTICA MAN.WOOD

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ABSTRACT

Atlas cedar (*Cedrus atlantica Man.*) is a typical tree species for the regions of North Africa. Trees reach a significant height of 35-65 m. The diameter of the trunk at the chest height ranges between 0.9-1.8 m that gives it a considerable economic interest. The hard core wood could be coloured from reddish brown to dark brown. The sapwood is with light brown to grey colour. The average density of wood is 550 kg/m^3, ranging from 500 to 600 kg/m^3. This tree species was introduced in Bulgaria at the beginning of the last century in parks and gardens. In the middle of the last century, forestlands were afforested in the regions of Haskovo and Kardzhali, so the quality of the wood should be known in view of its use. There is information that it is very suitable for making furniture, windows, doors and musical instruments. The conducted studies show that for our region the mechanical indicators of cedar are with better properties than those of *Pinus sylvestris L.*

Key words. Cedrus atlantica, wood quality

1. INTRODUCTION

In the past, the representatives of the Cedrus gender of the Pinaceae family were widely distributed in our areas. In our country the cedars were introduced at the end of the 19th century for the needs of landscaping and botanical gardens (Varna-Evksinograd, Stara Zagora-Ayazmoto, Sofia-urban garden). At the beginning of the last century in our parks and gardens, and later in the 1960s, the Atlas Cedar (Cedrus atlantica Man.) was introduced in Bulgaria. The wood of the Atlas cedar, similar to the fir tree, does not contain resin, but it is with a well-defined yellowish-brown core containing the following compounds: cement, tadrol, cedrylacetate and sesquiterpenes. These compounds are a source of pleasant aroma emanating from freshly cut wood. Due to their presence, the wood is resistant to fungal pests, and antiseptic (3). Interest in cedar wood increased over the last 30 years of the last century. It is widely used for afforestation of land in the regions of the Black Sea coast, Haskovo, Kardzhali, Stara Zagora and Blagoevgrad. Regarding the biological and forestry characteristics of the cedars, studies were made by Boyan Zahariev: 1965, 1983; B. Peev: 1965-1969; Zhelyaz Donchev: 1971; Dimitrov: 1973; K. Kalmukov: 1988, 1990, 2004, 2016; D. Kolarov and J. Kulleiev: 1989; Tsanov, Y. Naydenov and K. Kalmukov: 1990, (1; 2) Unfortunately, no studies have been made on the properties of the cedar wood; of its economic significance, which gave reason to the present study.

2. MATERIALS AND METHODOLOGY

To examine the physical-mechanical properties of the wood, an experimental sample of a 35-year-old tree with a trunk height of 18 m and a diameter of 45 cm in height was taken from the NDSRDW-Svishtov in the village of Vardim, situated at 15 meters altitude- terrace on the River. Danube. The soil is carbonate black earth, deep, poorly stocked with digestible nitrogen and phosphorous but with enough potassium. The mechanical composition of the soil is mainly sandy-

clayey and with good porosity and water content. The capacity of active moisture in the two- meter soil layer is over 500 mm. The average annual air temperature is 11.1 ° C, and the amount of rainfall over the last 50 years has been about 500 mm. The registered absolute minimum air temperature is -28.1 ° C, and the absolute maximum air temperature is 43.5 ° C. The amount of falling rainfall is the highest during the spring / summer periods. The experimental terrain was planted in 1972 with large-sized saplings taken from the decorative nursery of Rousse. The samples for examination of the physical and mechanical properties of the wood are taken from the section: 1.3-3.0 m in the form of non-adjacent central boards, with a thickness of 60 mm and a length of 1000 mm. After 3 years of indoor shelter, they are processed into blanks suitable for cutting test bodies. The test bodies are cut with clean tangential and radial sides with dimensions according to the requirements of the synchronized Bulgarian standards. Since quality is a set of custom properties for the purpose, this article sets the values of the following properties: density; static hardness; static bending strength; modulus of elasticity at static bending, shear strength parallel to the fibers; splitting resistance. The static hardness test pieces are 50x50x50 mm. 32 test pieces were used, and for each direction two tests were performed, i.e., in total 64 tests. Density test bodies have a size of 20x20x30 mm; for determination of the shear strength parallel to the fibers their size is 20x30x50 mm; for determination of the split resistance they have dimensions 20x20x50 mm; for determining the bending strength and the modulus of elasticity across the static length of the fibers they are sized 20x20x300 mm. 64 test pieces were used to determine the density.

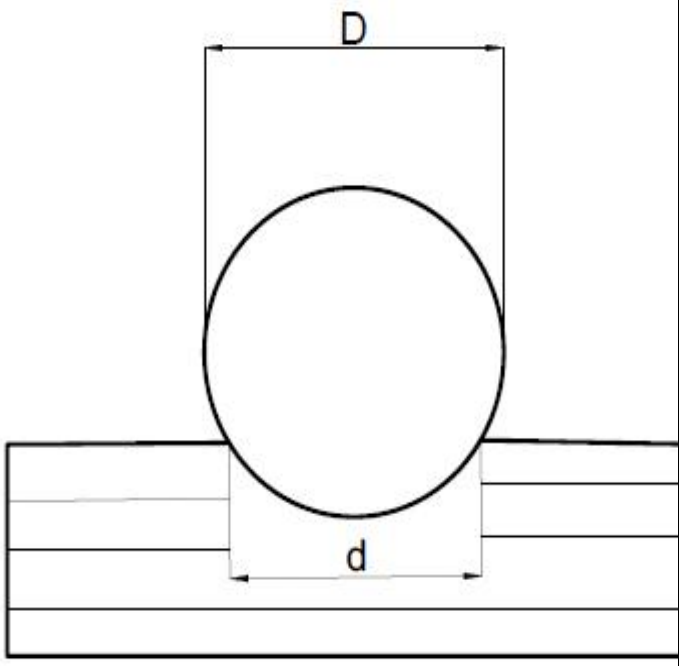

Figure1. *Brinell method for testing the hardness of the wood*

Figure 2*. Static hardness test according to the Brinell method*

The Brinel hardness values are calculated according to the equation (1):

$$H_B = \frac{F}{\pi . D . h}, [N/mm^2] \quad (1)$$

HB - hardness of the wood by the Brinell method, N / mm2;
F - applied load - 1000, N;
π = 3,14;
D - diameter of the steel sphere - 10, mm;
h - depth of penetration of the steel sphere in the wood - 0,75 ÷ 2,26 mm.

Forty test pieces were used to test flexural strength and modulus of elasticity. Calculation of modulus of elastisity and static bending strength was carried out by the equations 2 and 3, where E is modulus of flexural elasticity, N / mm^2; σ - bending strength, N / mm^2; Fmax - maximum load, N; h - cross-sectional thickness in bending, mm; δ - width of the cross-section of bending, mm; l - length of inter-support distance for determining modulus of elasticity, mm; f- is deflection / deformation at maximum load in mm.

3. RESULTS AND ANALYSIS

The variational and statistical results are presented here. It was found that the average density of the cedar wood in an air dry state at humidity (W_1 = 7.65%) is 617 kg / m^3, and in absolute dry conditions (W_1 = 0%) it is 573 kg / m^3.

The highest values are Brinel's static hardness in the longitudinal direction of 29.85 N / mm^2 and at least in the transverse direction 22.16 N / mm^2. The transverse hardness in both directions has close values: 23.85 N / mm^2 and 22.16 N / mm^2 respectively.

The difference of 1.69 N / mm^2 (23.85-22.16 = 1.69) between these two values is unreliable because the Student's Differential Verification Score has a value of 1.24, less than 3. The difference in the values of the transverse and the top Hardness (6.85 N / mm^2) is reliable, as the Student's ratio is 4.15, i.e., higher than the number 3.

Table 1. *Static hardness Brinell*

Markings of rigidity of Brinel in directions	Number of measurements , n	$\bar{X}$ N/mm^2	Stdev ± N/mm^2	Average error, m_x ± N/mm^2	Vx, %	Px, %
Crossly-tangential	64	23.85	8.142	1.02	34.14	4.26
Crossly- radial	64	22.16	7.235	0.90	32.65	4.08
Longitudinal-frontal	64	29.85	8.321	1.04	27.88	3.48

Based on the mean values, we obtain the graphical dependence of bending strength and modulus of elasticity. This dependence is presented in Fig.3

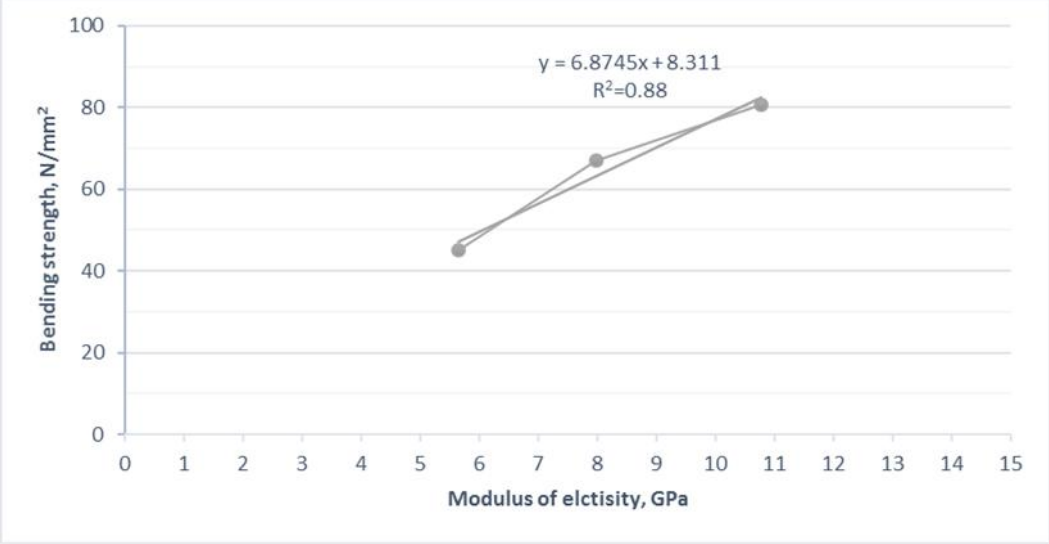

Figure 3. *Dependence of bending strength and modulus of elasticity in bending of cedar wood*

It can be seen from the graph that the relationship between bending strength and bending modulus is significant and it is most closely related to the linear equation **y = 6.8745x + 8.311.**

For **E = 10 GPa,** σ = 6.8745, E + 8.311 = 77.056 N / mm^2. As the module increases, the bending strength of the tested cedar wood samples increases accordingly. These high values of the tested parameters are due to the high density of the wood. By its mechanical qualities the cedar wood is superior to those of the local coniferous species: white and black pine, common spruce and common white fir.

4. CONCLUSION

The results obtained suggest that the wood of the Atlas cedar superior to its quality is the wood of the local coniferous species of white and black pine, spruce and fir. Having in mind that the experimental tree is comparatively 2-3 times younger than our mature coniferous species, the economic benefit of afforestation of our terrain with this alien-tree can be highlighted.

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