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Research Article

The Determination of Brinnell Hardness for Beech Wood (*Fagus Sylvatica L*) in Albania

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Abstract

This study regards the determinations of Brinnell hardness on Albanian beach (Fagus sylvatica L). The results showed that the Brinell-hardness of beech wood is 66 N/mm² 30.3 N/mm² and 33.4 N/mm² respectively for longitudinal, radial and tangential direction. Little research was carried out to compare of the Brinell-hardness of the normal and the red-hearted beech wood and it is shown that the hardness in the tangential section of the red-hearted wood are significantly higher than normal wood (+11.8%). On the radial section differences were smaller (+8.3%). The hardness values for samples of the first group (7-10 growth rings) tends to be higher (+16%) than the hardness of second group (11-15 growth rings). This is because the wood samples with small numbers of growth rings have the greater proportions of summer wood and the greater density of wood.

Keywords: *Brinnell hardness, Albanian beech wood, statistical parameters*

Introduction

Beech forests are the most spread hardwood in Albania. Beech takes around 63 % of Albanian forest fond (Fig. 1) and of course is one of the most important commercial hardwood species in Europe.

Beech forests in Albania mainly grow at high altitudes on mountains; from the north mountain to central Albania up to south east region. It can be found in pure forest or mix forest with other species as black pine, sycamore maple, white fir and white oak. Furthermore, beech wood has an economic importance for Albania along with fir, pine and oak species In the Albanian market, beech wood is utilized as sawn timber in furniture production.

Beech wood is classified as a medium-high density hardwood. It is red –brown in color. In many trees in the interior part near the sap is found the so called "red heart of the beech" which is dark in color and has irregular shaped edges, which is a negative and devaluating factor for the wood .The growth rings are narrow and have no clear cut edges, there is a thickening of the sapwood rays where they meet the growth ring and diffusively separate vessels. The wood texture is fine, with fibers often deviant in the helicoidally sense. The planning, sawing and milling are easily performed. We get V-headed timbers from the sawing process when we notice strong inner tensions in the trunk.(Kollman F.F.P., 1975).

Fig.1 The area occupied by beech wood in the Albanian territory

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The drying process is slow and is carried out in air dried ovens. We must make sure to avoid malformations and the collapse phenomenon. The production of technical and decorative veneer is easily done but it is always preceded by a treatment with softening vapors. As far as the nailing and screwing are concerned it can be preceded by drilling the holes first. After it is finished this is a strong enough juncture. The gluing and the polishing yield good results. The application of this material is vast. It is used for the production of technical and decorative veneer, the production of furniture framework, furniture, inner doors, wall and ceiling coating, staircases, floors, crates etc. As beech wood obtains good plastic properties throw the evaporation, it is successfully used in the production of bent furniture (chairs, tables etc) as well as barrels used for storing food products. The study of beech wood properties in general and the mechanical ones specifically is still a topic of great interest for the researchers and especially the wood processing industry. The aim of this work was to determine the hardness of Albanian beech wood and consequently to compare them with those of beech species of other origins.

Material and Methods

In Europe the most widely used hardness determination method is the Brinell test, whereas, predominately in North and South America the most commonly used method is the Janka test. The Janka method has not been accepted in Europe since there is a considerable possibility of failure due to the cell wall compression (Grekin *et al*. 2013). Brinell-hardness was measured according to the method described by Stübi and Niemz (2000) by the penetration of a steel ball into the wood surface.

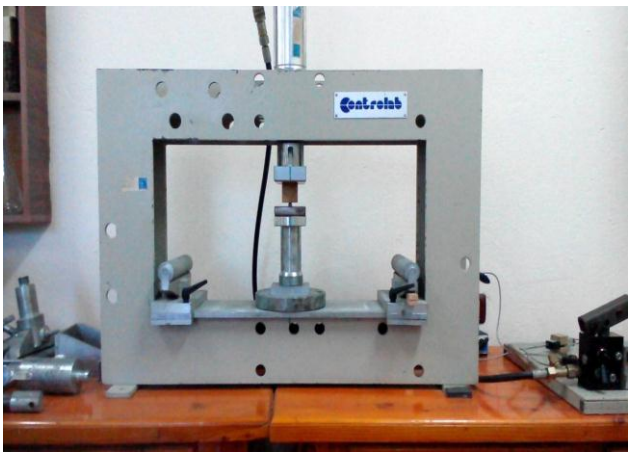

Fig.2 Testing machine

Table 1 The Statistical Parameters of Brinell hardness of beech wood in Albania

Statistical parameters	Longitudinal direction		Radial direction		Tangential direction	
	Sapwood	Red heartwood	Sapwood	Red heartwood	Sapwood	Red heartwood
Average (7-10 growth rings) (N/mm²)	62.6	58.9	23.4	25.4	25.8	29.2
Average (11-15 growth rings)(N/mm²)	67	63.5	29.5	31.2	31.1	34.6
Average (N/mm²)	62	66.7	27.7	30.3	29.8	33.4
standard deviation	4.2	6.8	2.6	3.0	2.9	3.3
coeff. of variation	7.1	10.1	10.8	8.8	11.9	9.65
minimum value (N/mm²)	52	56.2	19.0	22.3	20.9	24.6
maximum value (N/mm²)	66.2	78.3	31.9	39.1	35.2	43.1

The investigation was carried out according to DIN EN 1534 with a test load of 1000 N. The ball was loaded and reloaded for 20 sec and the time of retention of the maximal load was 30 sec. The samples were cut in dimensions of 40 × 40 mm at a maximally attainable length but not less than 500 mm. For each individual tree (two trees) 2 sample bars with red heart and 2 sample bars of normal wood were investigated. The number of measurements per tree and direction of cutting was 60.The moisture content of samples was 11.5%.

Results and discussion

First, Brinell hardness was examined perpendicular to grain (tangential and radial hardness) and parallel to grain (longitudinal hardness). The value of the indentation diameter was obtained as an average value of two measurements of cross diameters. According to the calculated mean diameter (D), the indentation area (A) was calculated using the formula:

$$A = \frac{D^2 \cdot \pi}{4} [mm^2]$$

After that, Brinell hardness (HB), was calculated using the formula:

$$H_{Brinell} = \frac{F}{A} = \frac{1000N}{A} \left[\frac{N}{mm^2}\right]$$

All samples are categorized in three groups according the numbers of growth rings in transversal section. First group of samples has 7-10 growth rings; second group of samples has 11-15 growth rings. The average moisture content of samples was 11, 3 %.

Conclusions

The comparison of the Brinell-hardness of the normal and the red-hearted beech wood showed clear differences between the two groups. On the tangential section the red-hearted wood showed significantly higher values than normal wood (+11.8%). On the radial section differences were smaller. The hardness in the samples with red heart tends to be higher (+8.3%).

Little research was carried out so far regarding investigations of the Brinell-hardness of red-hearted wood. (Molnàr *et al*.2001) compared the hardness of red-hearted and normal beech wood and showed that the hardness in radial and in tangential direction was up to 10% higher for the red-hearted wood. These differences could generally be confirmed in our investigations, however not in the same order of magnitude. There is also a difference in hardness values between two groups of species. The hardness in samples of first group (7-10 growth rings) tends to be higher (+16%) than the hardness of second group (11-15 growth rings). This is because the wood samples with small numbers of growth rings have the greater proportions of summer wood and the greater density of wood.

References

DIN EN 1534:2000 (*Wood and parquet flooring - determination of resistance to indentation (Brinell)*- test method

Grekin and Verkasalo 2013. *Variation in models for Brinell hardness of Scot Pine wood from Finland and Sweden. Baltic Forestry* 19(1): 128-136

Kollman F.F.P. and Cote, W. A. 1968. *Principles of wood science and technology. I. Solid wood.* Springer-Verlag, Berlin - Heidelberg, 592 pp

Molnàr S., Nemeth R., Feher S., Tolvaj L., Papp G., Varga F., Apostol T., *Technical and technological properties of Hungarian beech wood consider the red heart, Drevarsky Vyskum* 46 (2001) 21–29.

Stübi T., Niemz P., *Neues Messgerät zur Bestimmung der Härte,Holz-Zentralblatt 114* (2000) 1524, 1526.