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*Research Article*

# The Effect of Heat Treatment on the Compression Strength at Beech Wood (*Fagus Sylvatica* L)

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***Abstract***

*Wood is a biologic material widely used in construction, joinery, furniture, etc. Wood has a lot of disadvantages that affect the quality of production and decreases the field of utility. During drying, the structure and properties of wood are modified. The objective of this research was to investigate the effect of heat treatment on compression strength. For this purpose is used the beech wood, Fagus sylvatica, treated in high temperature $180^0$ C, $200^0$ C, $220^0$ C. This treatment causes the reduction of wood density in 2 %. The compression strength is not effected from the treatment at$180^0$ C. The greatest effect in the reduction of compression strength is noted at the treatment at $220^0$ C, around 10 %. The results of both treated and untreated samples were given, for comparative purposes.*

***Keywords:*** *Fagus sylvatica L, heat treatment, wood density, compression strength.*

## Introduction

Wood is a valuable material that is widely used in different applications. However, wood is also characterized by a number of disadvantages because of its hygroscopic nature, such as poor resistance against biological attacks of fungi and insects, as well as swelling and shrinkage caused by water absorption and desorption, depending on the environmental conditions. Therefore, these limit the outdoor applications of wood.

Many studies have been done so far, in order to improve the disadvantageous properties of wood, which are commonly named "wood modification methods". "Heat treatment" is a wood modification method and changes many physical, mechanical and chemical properties of wood, that is: dimensional stability, equilibrium moisture content (EMC), color of wood, bending strength, hardness, biological durability etc. (Wikberg and Maunu 2004, Olek and Bonarski 2008, Ábraham *et al*. 2010, Kocaefe *et al*. 2008 etc.) The heat treatment affects the wood cell wall polymers: hemicelluloses, cellulose and lignin. During the process, hemicelluloses start to decompose first, since they have the lowest molecular weight among the wood polymers and that makes them more reactive. Additionally, lignin softens, cellulose and hydrophilic groups modify. (Hakkou *et al*. 2006, Arnold 2007, Bachle *et al*. 2010, Niemz *et al*. 2010 etc.) As a result of this process, wood treated with high temperatures loses its reabsorbing water capacity contrary to hydrophilic behavior of the conventionally dried wood. The extent of the improvement in wood properties after the heat treatment depends on many factors such as thermal modification approaches, wood species, treatment time and temperature. The temperature and duration for heat treatment generally vary from 180° to 250°C and 15 min to 24h depending on the heat treatment process, wood species, sample size, moisture content of the sample, and the desired mechanical properties, resistance to biological attack, and dimensional stability of the final product (Tuong and Li 2010, Yao 2010 etc.).

Several changes in physical and chemical properties of wood already start to appear at the temperature of 150°C, and also the strength properties begin to deteriorate raising the temperature over 150°C (Ates *et al*. 2010). Unfortunately, the enhancement of some properties is accompanied by reduction in mechanical strength of wood, and the main reason is mainly the degradation of hemicelluloses which connects cellulose and lignin in the cell wall (Barboutis *et al*, 2011). Thermally treated wood has been investigated since the middle of the last century and is nowadays produced industrially in many European countries. However this kind of study is new on Albanian species.

#Corresponding author **Saimir Beqo** is a PhD Scholar; **Entela Lato**** and **Doklea Quku** are working as Professor and Assistant Professor respectively

## Material and Methods

The material of beech samples was obtained from Librazhd Region. The samples were sawn in dimensions 40 x 40 x 10 mm and there were put numbers for every sample. The samples were prepared according the UNI ISO 3130 standard. After this, the samples were condition to 8-9 % moisture content at 20°C and 60 % relative humidity. This was done to prevent splitting and discoloration of wood during heat treatment. For each experiment and each type of wood 10 specimens were prepared. After this, for all the samples were measured the weight and is determined the compression strength (DIN 52185:1976).

Three different temperatures (180º C, 200º C, 220ºC) and two different time durations of 15 min and 30 min were applied to the samples. The samples were placed in the oven after the desired temperature was reached.

After the heat treatment, the weight is measures for the samples. After this, the samples were condition at 20°C and 60 % relative humidity for ten days. The weight is measured again after the conditioning and is determined the compression strength and the weight loss because of high temperature treatment.

## Results and Discussion

The basic density of the beech wood samples was 0.628g/m3. Thermal treatment affected the weight of the samples as follow. The higher the temperature applied and the longer the duration of the treatment were the greater the reduction of the samples weight was (Fig. 2). The lowest percentage reduction of the samples weight (5.08%) appeared in the treatment of 15min at 180°C. The highest percentage reduction of the samples weight (13.4%) appeared in the treatment of 30min at 220°C

Air conditioning of the samples for 10 days after thermal treatment resulted in the moisture absorption from the samples and their weight increased respectively (see also Fig. 2). The lower percentage increase of the samples weight (2.27%) was measured in the samples of the most mild treatment (15min at 180°C) as it was expected, because they had not lost all their water content during treatment. The higher percentage increase of the samples weight (4.72%) was measured in the samples treated in 220°C for 15min.

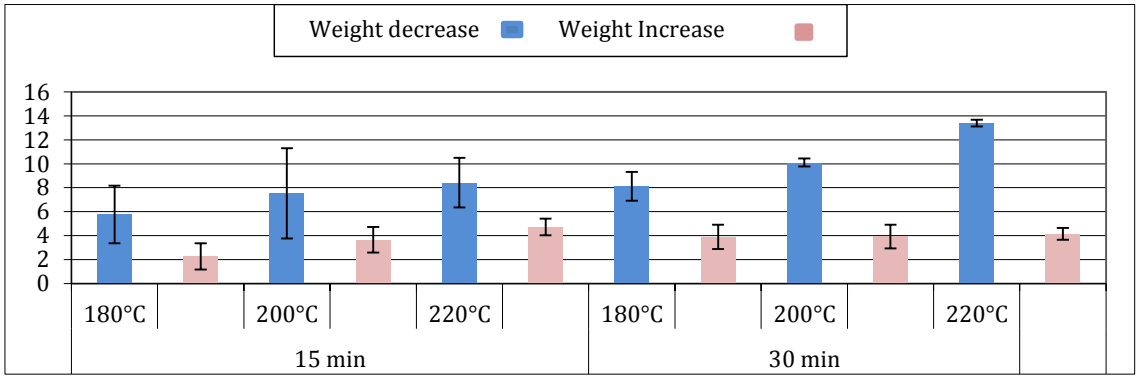


**Fig.1** Percent of weight loss after thermal treatment and weight increase after air conditioning for beech wood

**Table 1** Percent of weight loss after thermal treatment and weight increase after air conditioning for beech wood

| **Period of treatment** | **15 min** | | | **30 min** | | |
|---|---|---|---|---|---|---|
| **Temperature** | **180°C** | **200°C** | **220°C** | **180°C** | **200°C** | **220°C** |
| Weight loss (%) | 5,76 | 7,52 | 8,42 | 8,12 | 10,11 | 13,4 |
| Standard Deviation | 2,4 | 3,77 | 2,07 | 1,2 | 0,34 | 0,27 |
| Weight increase (%) | 2,27 | 3,65 | 4,72 | 3,89 | 3,92 | 4,15 |
| Standard Deviation | 1,1 | 1,07 | 0,7 | 1,02 | 1 | 0,5 |

**Table 2** Compression strength parallel to the grain (N/mm2) of thermally treated and untreated Beech wood

| | 180°C | 200°C | 220°C | Untreated |
|---|---|---|---|---|
| 15 min | 56.37 (3.60) | 57.20 (3.96) | 60.75 (4.05) | 62.16 |
| 30 min | 61.37 (3.41) | 58.82 (3.98) | 56.13 (2.66) | |

Regarding the compression strength parallel to the grain, all of the applied thermal treatments reduced the mean compression strength values of the samples, compared to the values of untreated samples. The reduction ranged from 1.22% in the treatment of 30 min and 180°C to 9.7% in the treatment of 30min and 220°C.

## Conclusions

This research shows that the effects of thermal treatment in 180°C, 200°C and 220°C for 30min. on beech wood compression strength is found to be significant. Specifically, the thermal treatment in 220°C affected greatly the values of the samples tested. On the other hand, the thermal treatment for 15min. in all temperatures applied had no significant effect on the values of the samples. This is attributed to the fact that only the samples treated in 200°C for 30 min. had lost weight over their moisture content which means that structural changes had occurred. More specifically, thermal treatment in 220°C for 30min. decreased significantly the compression strength.

Consequently, thermally treated beech wood could be utilized by using proper thermal treatment techniques in outdoors and indoors applications for several purposes.

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