Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 10 Issue 3, March - 2023

Moisture Level And Water Absorption In The Most Popular Types Of Woods In Albania

Arvi Kalaja
Department of Education, Faculty of Structural Engineering
Polis University, Tiranè Albania
Email: arvi_kalaja@universitetipolis.edu.al

Romeo Osmani
Department of Education, Faculty of Structural Engineering
Polis University, Tiranè Albania
Email: romeo_osmani@universitetipolis.edu.al

Kostandina Zaci
Department of Education, Faculty of Structural Engineering
Polis University, Tiranè Albania
Email: kostandina_zaqi@universitetipolis.edu.al

Klodjan Xhexhi
Department of Education, Faculty of Structural Engineering
Polis University, Tiranè Albania
Email: klodjan_xhexhi@universitetipolis.edu.al

***Abstract*—This paper is going to deal with water absorption in different types of wood such as: pine, oak, beech and fir. The amount of water absorbed by these types of wood is known as water absorption, and it is determined using the material's initial state and after their immersion in water.**
The major goal of this study is to explain the effects of water absorption in hardwood materials and to demonstrate the changes that will take place in them over the course of 48 hours.
Water can be absorbed by wood in a variety of ways, as a liquid, or as an atmospheric vapor. Despite the fact that wood can absorb other liquids and gases, water is the most important. Because of its hygroscopicity, wood, whether as part of a living tree or as a material, always contains moisture.
The experiment will be focused on the selection of different types of wood (most popular in Albanian context), analyzing their water absorption and moisture level. The wooden samples will be submerged in water for 24 and 48 hours in order to obtain the appropriate results. Their moisture level and water level due to capillarity will be analyzed too.
The purpose of the study is to follow the behavior of wooden frames in different environments.

Keywords—component: water absorption, wood, experiment, moisture level

Introduction

The environment around us has been changing significantly, and people are now worried about how the buildings they are creating may affect this interaction. This is one of the causes for the substitution of wood for steel and concrete in harsh constructions. The beneficial qualities of wood and its attractive appearance could be another factor. The major goal of the numerous research programs and initiatives that aim to improve the performance of structures, features connected to ecology, and energy performances is the evolution of the wood building industry.

The moisture content and its effects on wooden structures, or more specifically on elements, represent one of the most significant aspects that interfere with the healthy development of wooden elements that are part of the structure. The performance and strength of wood structures, especially the compression strength, are very important because under constant climatic conditions. The wood piece is subject to cracking and this can affect the load carrying capacity, moisture content and its effects on wooden structures.

The amount of moisture in wood affects its weight. For instance, freshly cut wood that is still green might weigh up to twice as much as wood that has been dried in an oven. However, there is a lot of information available on wooden qualities, and since not all of them uses the same standards or testing techniques, the results can vary. When the wooden object reaches an equilibrium moisture content with the outside air at a temperature of 20 and a relative humidity of 65%, a moisture content of 12-13% is usually measured. This value is considered as the standard. The density of the wooden item will decrease if it is deposited in several locations with lower relative humidity values. As was already mentioned, moisture content plays a significant role in how wooden materials change over time because, as highlighted in Eurocode 5, it "can affect the strength and stiffness properties of timber and wood-based elements and shall be taken into account in the design for mechanical resistance and serviceability". The effects of

moisture content and the alterations they can cause to wooden components must therefore be considered.

Studies have been conducted with experiments on different states of water presence in wood exposed to conditions established beforehand in a controlled environment chamber.

The test findings have been deemed pertinent in order to examine how moisture content affects the behavior of wood. Each time a change in the weighed mass of the wooden samples arose, wood deterioration was identified. The study's findings have shown numerous distinctions among the various phases of water present in wood, as well as the time at which degradation begins.

Moisture content facts

As previously mentioned, environmental factors play a significant role in the development of the mechanical characteristics of wooden components. This is due to the fact that wood is a hygroscopic substance with capacity to absorb water or release it into the environment in order to achieve a particular equilibrium with it. Due to the high temperatures and relative humidity, wood can either absorb water and swell or can desorb it, if the atmosphere is dry.

The graphic below illustrates several phenomena of changes that occur on wood under environmental circumstances which affect wooden components.

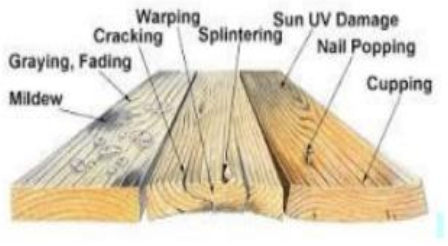

Figure 1. Swelling of wood and other phenomenon of wooden frames in contact with water for a certain amount of time (source: Fredericksburg Wood Restoration).

These constant modifications to wood's structural makeup can have an adverse effect on its mechanical characteristics and pose a threat to the structural integrity of the building in which they are im

plemented. A wide range of modification variables, such as changes in volume, damages (cracks, wood decay), or favorable environments for mold and bacteria, as well as modifications in strength, may be developed in the structure or wood. In some of the wooden elements in the current study show exterior modifications, such as cracks. These are visible in Figure 2, which explain the process after the wood pieces were taken out of the water and left in the outside

environment.

Figure 2. Changes on the wooden surfaces of elements. Source: Authors

Wood shrinks when losing moisture from its interior and swells when gaining moisture. The values of strength and elasticity decrease as moisture content rises. The fluctuations depend on the free water present in the wooden cells. There will be no impact on mechanical characteristics, if the variations in moisture content are observed above the fiber saturation point.

Methodology

The experiment will be conducted first of all by the selection of four samples of different types of wood such as: pine, oak, beech and fir wood cut with different sizes respectively (10x4.5x3.5);(8x6.7x1.8);(4.8x5.2x4);(4x6.2x3.5) as seen in the Figure 3.The raw material will be provided from the sapwood for each category.
The samples will be submerged in water for 48 hours. Furthermore, they will be removed from the water and measured with instrument to determine how much moisture they have absorbed over the past 48 hours. Furthermore, the second experiment will be conducted in the outside environment, leaving the samples outside in order to observe their temperatures fluctuation and moisture level, over the course of 24 hours.
For the measurement of the moisture of the wood elements, was used "SILVERLINE - Digital Moisture Meter" device, while for the measurement of the temperature of the samples was used the „MESTEK - INFRARED THERMOMETER" device.

Fig. 3 – MESTEK - INFRARED THERMOMETER and SILVERLINE Digital Moisture Meter.
Source: Authors

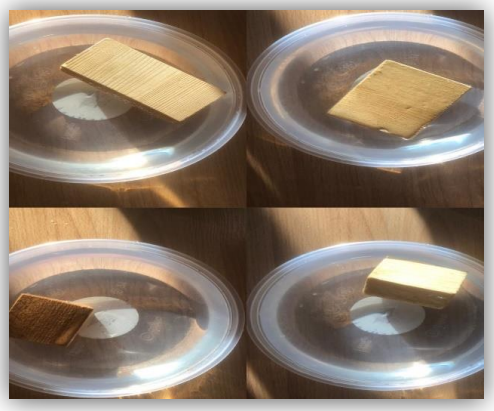

Figure.4-Wood samples inside the containers filled with water Source: Authors

1. INDOOR MOISTURE CONTENT AND TEMPERATURE FLUCTUATIONS FOR WOOD SAMPLES

The main principle of the experimental campaign is determining the moisture content by measuring the moisture and temperature of the pieces of wood before and after leaving them inside the water, furthermore leaving them dry in the outside environment. In order to have some real data on how temperature and humidity influence the moisture content in wood, experiments have been conducted in a room where the average temperature during the time period in which the measurements were performed and the final results were obtained, fluctuated between 20-23 degrees Celsius. The measurements were performed on January 15-16-17/ 2023 during 10.00-11.00AM. Indoor and outdoor temperatures and humidity can have different values that is linked with surrounding environments depending on climate: low or high temperatures or when the humidity intervenes in the modification of structural elements that are part of a construction. In this manner, the natural weather conditions are ideal for testing material performances, for example their resistance, in warm or cold environments. The temperatures that are presented are variable, therefore, during the entire process of measurements, they must be monitored in order to provide accurate values and to select the right wooden material that presents the most favorable results for the construction field, whether they are part of supporting structures or not

Figure.5-Wood samples in a dry condition Source: Authors.

Figures 4-5 show the environment in which the samples have been placed in order to change their moisture content for a period of 48 hours, before and after they were placed in water. After the pieces of wood were left in water for 24 hours, they were taken out of the water and the moisture they absorbed during this time interval was measured, with the corresponding device. The same method was used for the next 24 hours. The final results were obtained which will be presented through line graphs below.

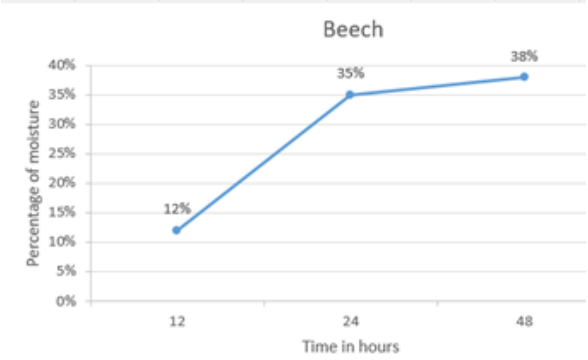

Figure.6-Beech average moisture content graph.
Source: Authors

The graph shows the moisture levels for Beech sample during 48 hours. In the first 12 hours, the humidity reached 12%. After 24 hours, the measured humidity reached 35% and during 48 hours it reached 38%.

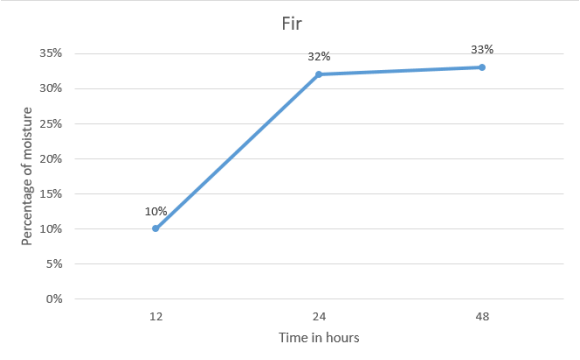

Figure 7-Fir average moisture content graph.

Source: Authors

The graph shows the moisture levels for fir sample during 48 hours. In the first 12 hours, the humidity reached 10%. After 24 hours, the measured humidity reached 32% and during 48 hours it reached 33%.

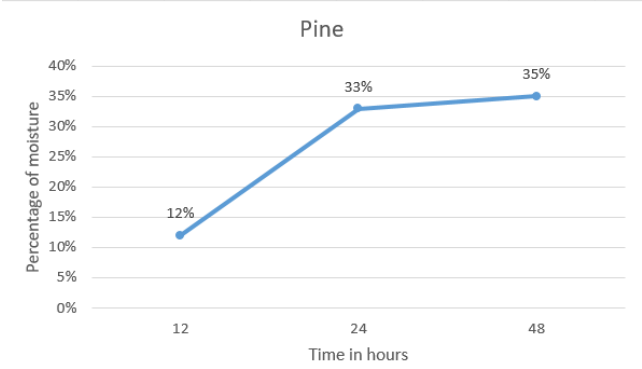

Figure.8-Pine average moisture content graph.

Source: Authors

The graph shows the moisture levels for Pine sample during 48 hours. In the first 12 hours, the humidity reached 12%. After 24 hours, the measured humidity reached 33% and during 48 hours it reached 35%.

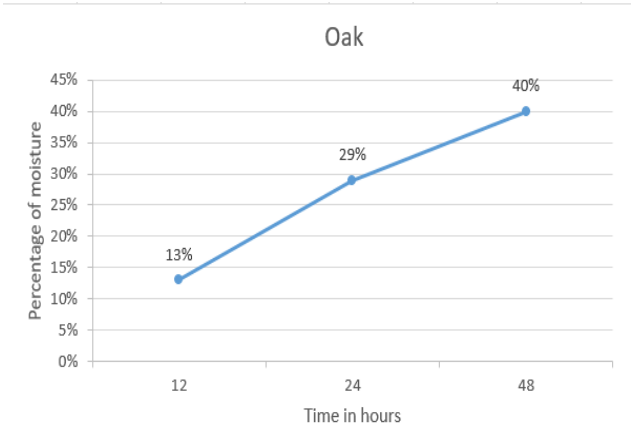

Figure 9-Oak average moisture content graph

Source: Authors

The graph shows the moisture levels for Oak sample during 48 hours. In the first 12 hours, the humidity reached 13%. After 24 hours, the measured humidity reached 29% and during 48 hours it reached 40%.

1. OUTDOORS MOISTURE LEVELS IN WOOD SAMPLES

A wood product can include water in two different ways: as free water (in the center of the wood's cells) or as bound water within the cell walls of the wood. In addition, it is important to

measure the moisture and temperature levels in the outdoor environment. Doing so, the behavior of different types of wood in natural outdoor conditions can be determined, which can also be affected by different atmospheric agents.

The moisture measurements were carried out with the same equipment as in the first experiment, while the temperature was measured with infrared thermometer. During the experiment, the humidity and temperature for 24 hours were respectively 60% and 13 degrees Celsius. The measured values are shown in the graphs below.

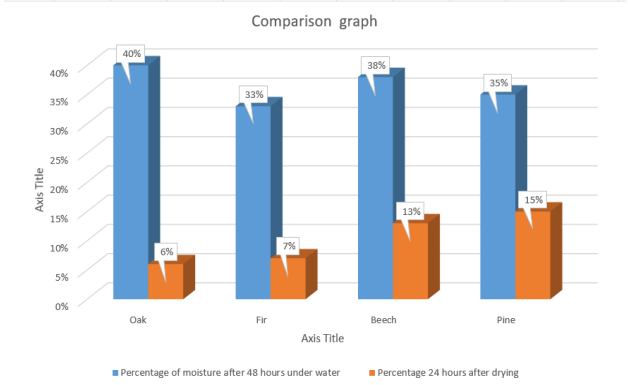

Figure 10 –Comparison graph of maximum absorbed moisture with the remaining moisture after drying Source:Authors

The graph below compares the maximum percentage moisture absorbed for four different types of woods, respectively oak, fir, beech and pine, for 48 hours, considering the moisture remaining in the material after drying for 24 hours in the outdoor environment. The graph shows that oak absorbs high amounts of moisture during 48 hours, respectively 40% but also manages to remove the largest amount of moisture (35%) compared to other types of wood, for a drying time of 24 hours. On the other hand, fir, beech and pine samples moisture percentages after drying were respectively 7%; 13% and 15%.

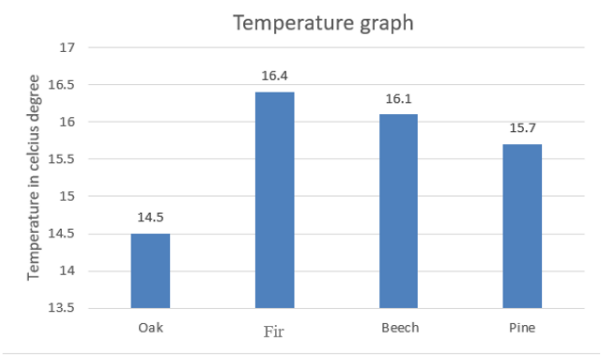

Figure 11 –wood samples average temperature graph. Source: Authors

The graph presented above shows the results of the temperature of the pieces of wood after the drying process for 24 hours. The temperature values for oak, fir, beech and pine are respectively 14.5;16.4;16.1;15.7-degree Celsius

2. Conclusions

The study presents the experimental procedures made on four different species of wood Oak, Fir, Beech and Pine. The results show how these species respond in real time at certain environmental conditions according to temperature and humidity variations, changing their interior moisture content. Wood has this ability to change according to its environment and it can absorb water or lose it, depending on the climatic conditions. This study has shown that by changing the environment, the mechanical and physical characteristics of the samples change too. This can be dangerous for the supporting structures in which the elements are used. Furthermore, new efforts can appear, and they can even be distorted by retaining or disposing water.

After drying Oak loses water much easily than other wood samples, even the moisture percentage is higher for Oak (40%). In the process of water intake, the differences are not that big between the four species (less than 5% for each sample). The results between the four wood species depend on the moisture content but also on the type of wood, the species (hardwood or softwood) and the physical and mechanical properties that they have.

The article demonstrates how variations in the moisture level of wooden components affect their volume, density, mechanical characteristics, and external features like cracks or create the ideal conditions for mold growth and biological attacks. This is why these alterations, when added to structures, may affect the integrity of the wooden components and, ultimately, the integrity of the entire building.

4. References

[1] *EN 1995-1-1 Eurocode 5: Design of timber structures - Part 1-1: General - Common rules and rules for buildings (European Committee for standardization Brussels*

[2] *Bader M and Nemeth R Sciences 2017 Hygroscopicity of Longitudinally Compressed Wood Acta Silv. Lign. Hung pp 135–144*

[3] *Carll C and Wiedenhoeft A 2009 Moisture-Related Properties of Wood and the Effects of Moisture on Wood and Wood Products Moisture control in buildings: the key factor in mold preventions ed 2nd West Conshohocken chapter 4 pp 54-79*

[4] *EN 384:2004 Structural timber-Determination of characteristic values of mechanical properties and density (Brussels)*

[5] *Ahlgren PA, Wood JR, Goring DAI (1972) The fiber saturation point of various morphological subdivisions of Douglas-fir and aspen wood. Wood Sci Technol 6:81–84*

[6] *Bertolin C, Ferri L, Strojecki M (2020) Application of the Guggenheim, Anderson, de Boer (GAB) equation to study the impact of sealing treatments on pine wood sorption characteristics. Mater Des Process Commun 3:e189*

[7] *Chen CM, Wangaard FF (1968) Wettability and the hysteresis effect in the sorption of water vapour by wood. Wood Sci Technol 2:177*

[8] *Engelund ET, Thygesen LG, Svensson S, Hill CAS (2013) A critical discussion of the physics of wood-water interactions. Wood Sci Technol 47:141–161*

[9] *Albrektas D, Ukvalbergienė K (2015) Impact of wood species, dimensions and drying temperature on sorption behaviour of wood. Drv Ind 66:1–10*

[10] *Engelund ET, Thygesen LG, Svensson S, Hill CAS (2013) A critical discussion of the physics of wood-water interactions. Wood Sci Technol 47:141–161*