

WATER ABSORPTION AND WOOD SWELLING FOR SPRUCE AFTER TOTAL IMMERSION

A. Lunguleasa

Transilvanian University of Braşov

1. INTRODUCTORY ASPECTS

Spruce wood is the best used species from resinous species from our country and from eastern Europe. Its utilisation in wet field or in free air will conduct to water sorption and the swelling in thickness of wood. Therefore is necessary the quantitative knowledge of the two phenomena and especially their dynamic, corresponding to the saturation moisture content and even after that.

When water entered the wood, water will be decomposed in its dipolous OH and H and dipolous H⁺ will form inter-molecular links with free OH⁻ from wood (that confer a important negativ potential for wood), namely from cellulose. In this way in the system of linking forces will be produced an disempointing and for equilibrium the micelles will be going away and wood will swollen on ensemble.

Wood is an hygroscopic material that can receive or loose water into, respectively when the climatic conditions are change, the moisture content will be change too, and the wooden dimension will be change. Therefore is necessary to know the water absorption and the wood swelling (the best two phenomenon) especially for spruce species that is so known in all utilisations. Very important is to determine the dynamic of these phenomena.

2. WOOD SAMPLES AND METHODOLOGY OF TESTING

For studying these two phenomena (dynamic of mass sorption and for thickness swelling) it were taken wooden samples from clean and sound wood (the average of annual rings were about 1.5 mm), with dimension of 20×20 ×100 mm which were conditioned to 12 % moisture content in laboratory chamber, with constant parametrs of air atmosphere. Then for each wooden sample were measurement the initial mass and their initial dimensions on thickness, respectively on tangential and radial direction (see fig 1).

Then, samples were introduced in water, keeping constatly the lever of sample under water to 5 cm and the temperature of water at 20 °C, by thermostation.

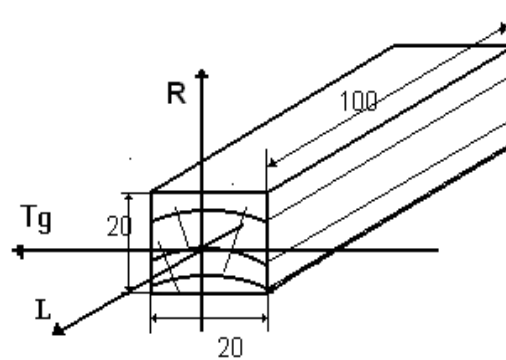


Figure 1. Wooden samples for experiments: R- radial direction; Tg-tangential direction.

At the time of 15 minutes in the first hour and from hour to hour after that, wooden samples were get out from water immersion and were weighted to balance for mass and where measured the two dimensions of thickness on tangential and radial direction. All values of weights and thicknesses were centralized in tables for each samples and make on these results a lots of graphes.

For instance in the table 1 is presenting the variation of mass in time, for four samples and in the table 2 the dimension variation in time, specifying the phases of each two phenomena.

3. ANALYSIS OF RESULTS FOR WATER MASS ABSORPTION

Even if each wooden sample has a distinguish individuality (given by wood structure, number of annual rings, percentage of late wood, visible and un-visible defects, porosity and so on), in the time of experiments it will observe that the two phenomena keep the same characteristics, valuable for all immersed samples. In this way it will observe for water absorption, two distinguish periods as follows:

- **Phase I-** Period of rapidly absorption of water of the starting period (usually first hour), when wood quickly absorb water because wood is absolutely dried and all cavities from wood are free of water. Velocity of water absorption in this period is very quickly. If we study the water absorption for 2 number of wooden sample, it will observe for all 10 hours taking in consideration for absorption, this

sample will increase its mass from 17.3 g to 22.1 g, namely 4.8 g, that mean the medium speed of water absorption is 0.48 g/h, for first hour is greater respectively from 17.3 to 19.8 g, respectively with a speed of 2.5 g/h namely over 5 fold as medium one. The same analysis of water absorption for 2 number of wooden samples will show us a difference of mass from 13.0 to 16.9 g, namely an medium speed of absorption of 0.39 g/h, but for first hour we have an difference from 13.0 to 15.2 namely an velocity of 2.2 g/h, respectively over 5 fold as medium one. More visibility of phases and speed of absorption inside of the same phase will be shown on the graph, as we see in fig 2.

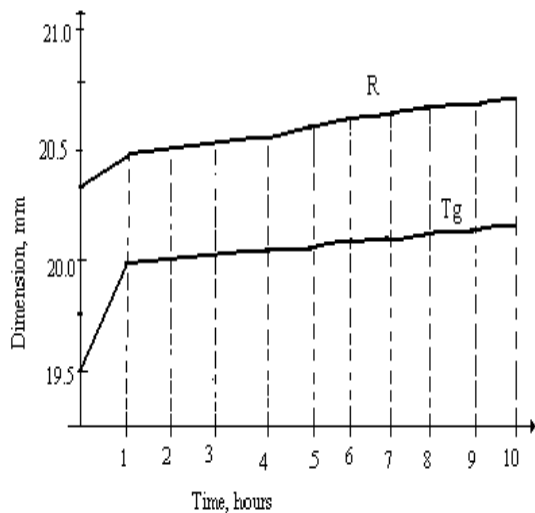


Figure 2. Mass variation for wood sample number.

- **Phase II** of water absorption named also period of concave curve when the speed is reduced and value are as medium ones. This form of curve show us that in this time is happened the volumic contraction of water from capillaries; final phase is with concave form, respectively there is a last spring of water absorption, after what will happen a decreasing of speed and a stabilising of water absorption speed.

4. ANALYSIS OF RESULTS FOR DIMENSIONAL VARIATION

If we study the dimensional increasing during water absorption and its dynamic it will observe two distinguish phases, namely:

- **Phase I** with rapidly increasing of dimension, the velocity of dimension increasing being the best one. If we make an calculus for wood sample number 1 it will observe an medium increasing of 0.08 mm/h, but in the first hour this increasing is 0.26 mm/h, respectively we have a ratio for 3.2 time

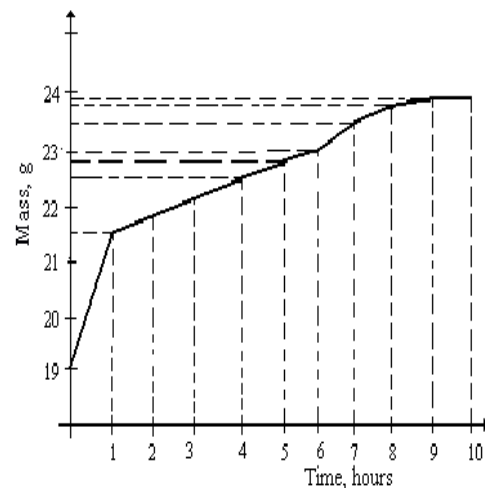


Figure 3. Variation of dimensions in time for wood sample no 2: R-radial; Tg-tangential.

related these. In this period the coefficient of swelling will be 4.03 on tangential direction and 1.84 on radial direction;

- **Phase II**, with lower increasing of dimension or phase of concave variation up to the increasing is appropriate to zero.

These aspects referring to dimension variation are more visible on graph from figures 4 and 5. The two periods are found on all wooden samples which are immersed. Quantity of water absorbed in all wooden samples are approximately equal in the field of 4.5-5 g., but different as each phases.

5. ANALYSIS OF RESULTS FOR COMBINED DIMENSIONAL AND MASS VARIATION

When we make combined analysis (for mass and dimensional variations) we can observe that graphs are proportional, respectively with increasing of water absorption in wood sample (velocity of water absorption is higher) the all dimensional increasing will be higher (velocity of dimensional increasing will be higher) in the field of 10 hours. This fact will create us the image of both increasing in time as we see in nomogram from figure 6.

From this study we take a conclusion related to these phenomena namely when dimension of wooden sample are equal and the structure of wood sample is the same the increasing of mass and dimension will be the same. Other condition of influencing can be about temperature of water, position of wood samples under water but the main one is the above said respectively width of annual ring for this spruce species. Also from this diagram we can extract mass and dimension of wood sample

Table 1. Mass variation in time.

Nr.	Initial mass	Mass in time, g										
		Min 15	Min 30	Min 45	Min 60	4 hour	5 hour	6 hour	7 hour	8 hour	9 hour	10 hour
1	19.0	21.3	21.5	21.5	21.6	22.5	22.8	23.0	23.5	23.8	23.9	23.9
2	17.3	19.4	19.6	19.7	19.8	20.7	21.0	21.5	21.8	22.0	22.1	22.1
3	13.5	14.4	14.6	14.8	15.0	16.0	16.7	16.9	17.	17.1	17.3	17.4
4	13.0	14.3	14.7	15.0	15.2	15.6	16.5	16.7	16.8	16.9	16.9	16.9
Phases		Phase I				Phase II						

Table 2. Dimensional variation in time.

Sample		Dimensions in time, mm											
		Initial	Min 15	Min 30	Min 45	Min 60	4 h	5 h	6 h	7 h	8 h	9 h	10 h
1	R	20.56	20.64	20.64	20.65	20.68	20.83	20.85	20.87	20.90	20.93	20.95	20.96
	T	19.84	19.98	20.05	20.08	20.10	20.48	20.57	20.60	20.62	20.64	20.65	20.66
2	R	20.30	20.35	20.40	20.45	20.47	20.56	20.60	20.64	20.66	20.68	20.69	20.70
	T	19.72	19.75	19.82	19.92	19.94	20.04	20.07	20.10	20.19	20.22	20.24	20.26
Phase		Phase I				Phase II							

2 after a certain time. It can observe from diagram that after 5.5 hours for wood sample no 2, the mass would be 21.2 g and the dimension would be 20.62 mm on radial and 20.09 mm on tangential direction.

If we go straight ahead on this way we can obtain the mass or dimension increasing at any times as we see in fig 7.

It can observe that for wood sample no 2, after 5.5 hours, the mass increasing is equal with 3.9 g and the dimension increasing is 0.32 on radial direction and 0.37 on tangential direction.

After analysing the fig 7 we see general tendency of curves and can make an graph with general increasing for a lot of samples with characteristics presented above and in the same condition of work, graph that is presented in figure 8 (in this graph we enlarge the division scale of dimensions and decrease the division scale of time for obtaining proportionally scale on horizontal and vertical lines). It can observe that after 3 hours wood pieces will have an increasing of mass with 3.1 grams and a dimensional increasing with 0.23 mm on radial direction and 0.3 mm on tangential direction. In this way we can obtain value of mass or dimension increasing after any time.

CONCLUSIONS

This work presented some researches about dynamic of water absorption and thickness swelling, respectively which are the tendency curves for both phenomena, phenomenon which are in correlation each others.

The idea of mass knowing or dimension increasing

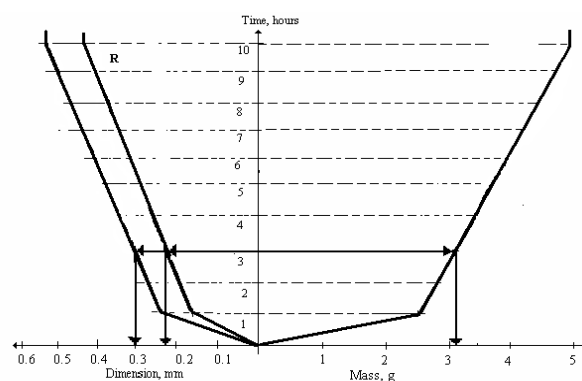


Figure 7. Increasing of mass and dimension of any wood sample after immersion in water.

after a certain period of time is good to know when wood is used under water.

These researches are preliminary ones because is studied a single species as spruce and are do not keep into account a lots of factors. In the future the researches will study influence of species (group as resinous or broad-leaved, or individually as beech, oak etc), of sample dimensions, nature of liquid and its temperature, etc.

References

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