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EXPERIMENTAL RESEARCH ON THE INFLUENCE OF THE WOOD SPECIES TYPE ON THE DEFORMATION OF LIGNIN-CELLULOSE BASED PANELS

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ABSTRACT
A lignin-cellulose based panel could be made of different hardwood species (mixed wood) as: beech, maple, cherry, nut, ash, oak wood. These wood species are characterized through different physical properties (density, swelling and shrinkage) and different elastically properties (E, G, ν). The deformation of the lignin-cellulose based panel depends also on the climate parameters (φ, T) and on the load on which it is subjected.

The paper presents the experimental research on some lignin-cellulose based panels made of mixed hardwood species, in order to establish which wood species could be combined, taking into consideration the variables mentioned above, so that the deformation of the panels to be minimum. The conclusion is based on the diagrams of the experimental data, two of them shown in figure 1, for different mixture of species in the lignin-cellulose panels..

Keywords: lignin-cellulose based panel, swelling, shrinkage.

1. INTRODUCTION
Due to its anisothrop-orthothrop properties, the wood as a raw material for finger jointed panels can interfere with the humidity in the air, thus absorbing or releasing water with the influence on the dimension sizes variation and also on their mechanical properties. The question this paper intends to answer is what species of hardwood can be mixed with beech wood in order to obtain composite finger-jointed panels. The answer is expressed by the stability of the panels during a long period time in different environments. The stability of the panels could be determined through the measurement of the panel's flatness in nine points. The phenomena occurred when the panels were placed in an environment with a low or high relative air humidity was shrinkage or swelling of the wood and also the deformation of the panels. Thus, the lignin-cellulose based panel deflection (Δ) can be expressed as a function dependence of the variables which shows the elastically parameters and the climate parameters, as resulted from equation 1 and 2.

$$\Delta = f(p, E, G, \nu),\ \text{mm} \qquad (1)$$

$$\Delta = f(\varphi, T),\ \text{mm} \qquad (2)$$

in which:

p - the load on which the panel is subjected to, which can be a concentrated or a uniformly distributed one, N;

E - longitudinal modulus of elasticity, MPa;

G - transversal modulus of elasticity, MPa;

ν - Poisson coefficient;

φ - relative humidity of the air, %;

T - air temperature, °C;

2. SAMPLES, EXPERIMENTAL METHOD AND EQUIPMENT

The samples used for the experimental method are finger jointed panels of 500x250 mm format, made of beech wood mixed with the following hardwood species: oak, ash, cherry, maple and nut wood, as seen in figure 1.

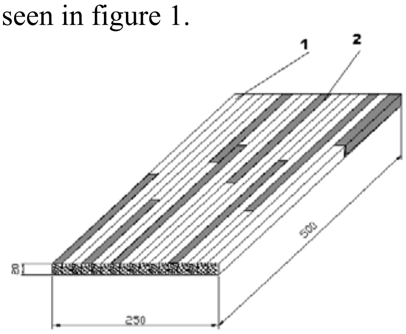

Figure 1. The sample panel; 1-beech wood; 2-beech, oak, maple, ash, cherry or nut wood.

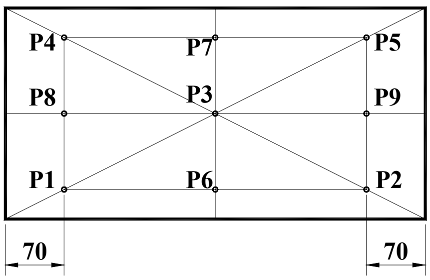

Figure 2. The nine points of measuring the flatness of the panels.

The samples were plased in a rack, being supported on four fulcrums, as can be seen in figure 3. They were not loaded with any concentrated or uniformly distributed forces, but they intended to look like the shelves of a furniture piece and they were placed into three different environments with various air humidity and air temperature. The aim was to measure the flatness of the panels in the nine points shown in figure 2. The flatness was expressed by the differences between "z" sizes measured in the nine points. The measurements were made at regular periods of time (one week) during three months. The "z" sizes were measured with high accuracy (0, 02 mm) using modern equipment (CADesQ) used to measure the manufacturing accuracy, as seen in figure 4. The "z" size consists of two components: thickness of the panel which is a variable because it depends on the air humidity and air temperature and could be higher or lower depending on the swelling and shrinkage phenomena, the second component being the deformation of the panel in the nine points. The position of the "z" axis on the panels is shown in figure 5.

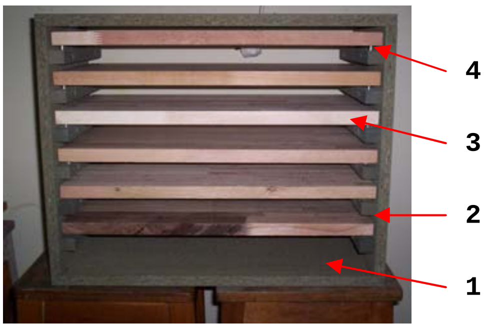

Figure 3. The device in which the panels were supported on; 1-rack; 2-wooden fillet; 3-panel; 4-fulcrums.

Figure 4. CADesQ equipment used to mesure the panels flatness.

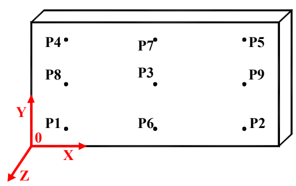

Figure 5. Position of "z" axis.

3. EXPERIMENTAL RESULTS

In order to observe how the wood species combination influences the stability of the finger jointed composite panels, let's follow the experimental results obtained on the panels placed in an environment with a low relative air humidity (37-60%) and high temperature (20-32°C). The six types of tested samples were in the following combinations of hardwood: beech-beech, beech-maple, beech-cherry, beech-ash, beech-oak and beech-nut. The experimental results are shown in diagrams from figure 6 to figure 11. Each diagram represents the "z" size measurements in the nine points during the three months the experimental work was performed.

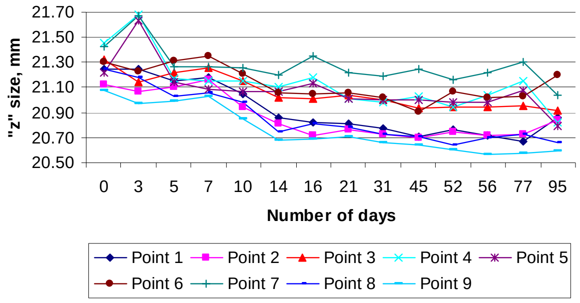

Figure 6. The curves of "z" size variation in the nine points for combination beech-beech.

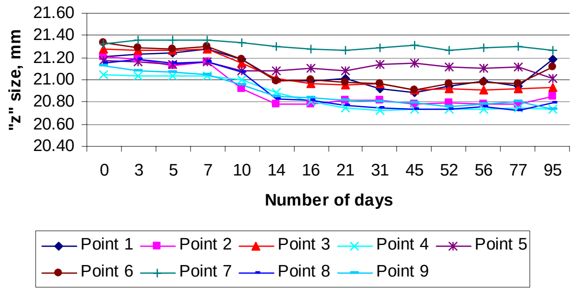

Figure 7. The curves of "z" size variation in the nine points for combination beech-maple.

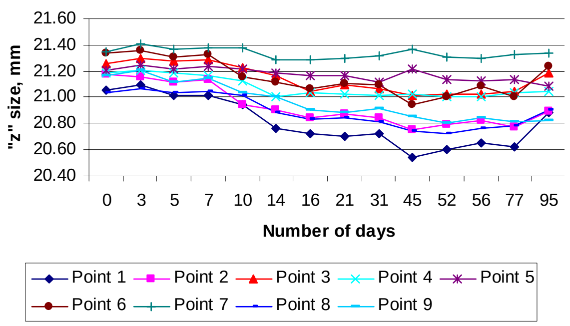

Figure 8. The curves of "z" size variation in the nine points for combination beech-cherry.

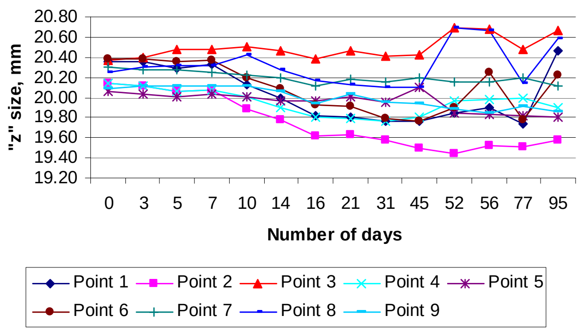

Figure 9. The curves of "z" size variation in the nine points for combination beech-ash.

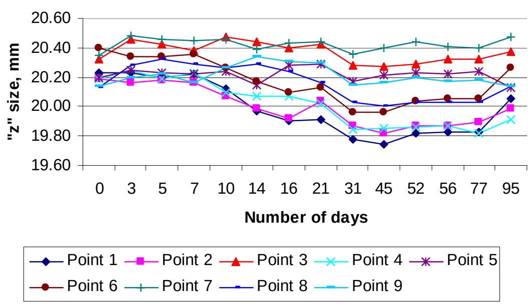

Figure 10. The curves of "z" size variation in the nine points for combination beech-oak.

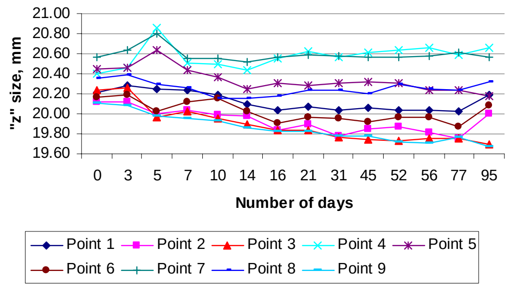

Figure 11. The curves of "z" size variation in the nine points for combination beech-nut.

4. CONCLUSIONS

The tendency of the curves represented in the diagrams from figures 6 to 11 indicates the shrinkage phenomena due to the fact that the initial relative air humidity was 60% and the final one 37%. In the same time the rises and decreases of the curves indicate the deformations of the panels. Comparing the curves of the six combinations of hardwood species can be observed that the most constant variation belongs to the composite panels made of beech and maple wood. In the same time the most unfavorable combinations seem to be the combinations between beech wood and ash wood, beech wood and oak wood and also between the finger-jointed panels made only of beech wood lamellas, that panel being considered as a standard one. That means the maple wood "calms down" the tensions of the beech wood.

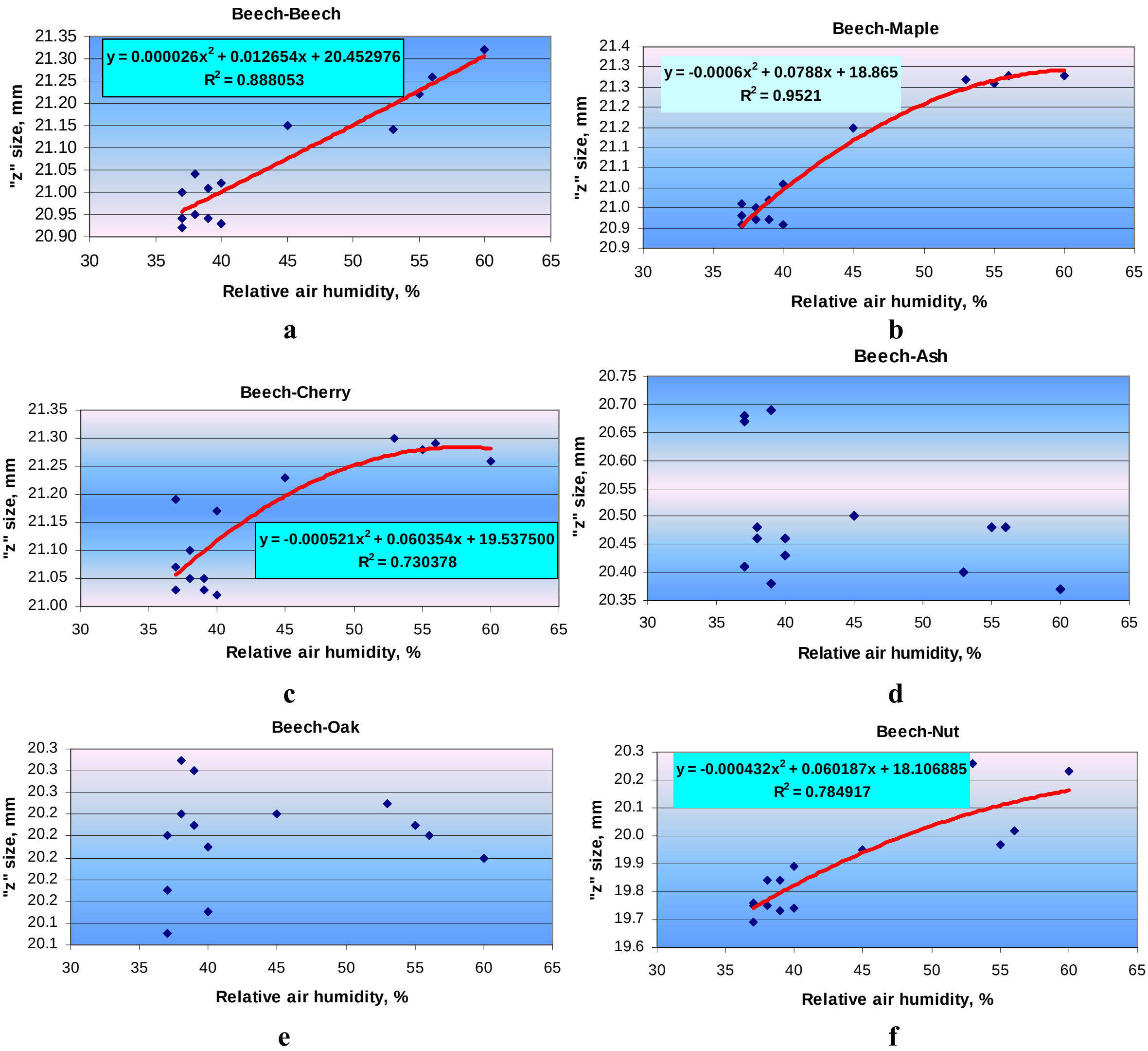

Figure 12. The dependence of the "z" size variation and the relative air humidity, the expression of the deformations for various combinations of hardwood species.

The same conclusion mentioned before is shown by the diagrams in figure 12 which represents the dependence between the variation of „z" size and the relative air humidity. Trying to find the regression curves of the functions, it could be observed that it was not possible to be found for combinations beech-ash wood and beech-oak wood. The explanation is as follows: the direct dependence between the „z" size and the relative air humidity is influenced by a clear shrinkage phenomena and the values are narrow and the regression curve exists. In case the deformations appear, the obtained values are spread in the graph and it isn't possible to find a regression curve. So, the deformations were high for combinations beech-ash wood and beech-oak wood.

5. REFERENCES

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