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ASPECTS REGARDING THE DEFORMATION OF THE LIGNIN-CELLULOSE BASED PANELS IN AGGRESSIVE ENVIRONMENT

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ABSTRACT
The paper presents an experimental research on the lignin cellulose based panels composed of lamellas of hardwood (beech and other hardwood species), subjected to aggressive environmental conditions. The idea of the experiment is to find the deformation of the panes depending on the climate factors (φ,T), so three different environments have been chosen in order to cover the maximum range of the relative humidity of the air (φ) and the temperature (T).
The variation of those parameters mentioned above during the time of experiment (3 month) and also the results are shown using a multitude of diagrams.
Keywords: lignin-cellulose based panel, aggressive environmental conditions, hardwood species.

1. INTRODUCTION
The paper presents an experimental research on the composite panels made of mixed lamellas of beech and other hardwood species (maple, cherry, ash, oak, nut wood) subjected to aggressive environmental conditions: interior ones, characterized through high temperatures (>30°C) and low air humidity (<40%) and exterior ones, characterized through winter climate with low temperatures (<0°C) and high air humidity (65% - 90%). The flatness of the panels have been measured in nine points with a very modern electronic measurement equipment (CADesQ) with a precision of 0,02mm and the deformations and the shrinkage and swelling phenomena have been monitorized during the three month of the experimental work. The deformation of those panels has been compared with a standard panel made of beech wood lamellas finger jointed on length and edge jointed on width. Usualy the wood panels are made of lamellas of one species of wood. In Romania the most popular species of hardwood used for finger-jointed-panels are beech and oak and than maple and ash wood. Using a single species of wood for the above mentioned panels, the risk of appearing the defects (cracks and delamination) seems to be diminished, because the wood behaviour is similar in this case (but not identical due to the anisotropic-orthotropic property of the wood) for all the lamellas.
In case of mixed wood (combination of at least two species) panels, the behaviour when absorbing or releasing the water in/from the cells is different for different species and the possibility of appearing the stresses inside the panel seems to be much bigger than in the previous case. The stresses lead to deformations and defects appearance. How the lignin-cellulose based panels' flatness is influenced by the environment conditions, the paper will show herein.

2. SAMPLES, EXPERIMENTAL METHOD AND EQUIPMENT

The samples used for the experimental method are lignin-cellulose based 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.

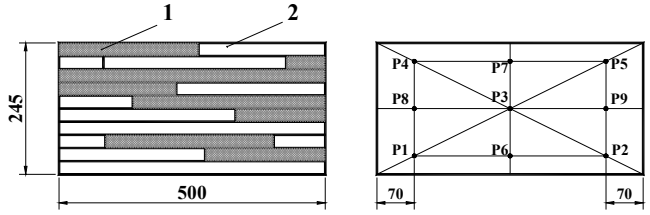


Figure 1. The sample panel; 1-beech wood; 2-beech, oak, maple, ash, cherry or nut wood, and the nine points of measuring the flatness.

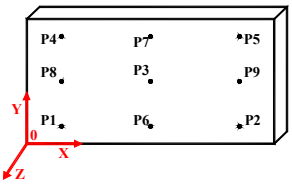


Figure 2. The position of "z" axis for measuring the flatness of the panels in the nine points.

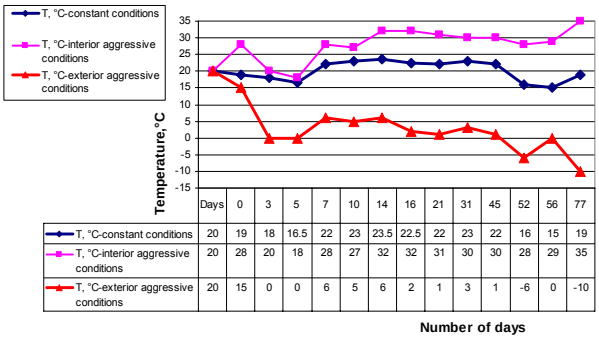
The samples were placed in a rack, being supported on four fulcrums, and the racks were placed in three different environments: an exterior one (outside but protected against the rains and snow) in the winter time, an interior one (near a thermal heat source) and in a constant environment, in a conditioning room with approximately constant parameters (relative air humidity and temperature). The measurements were made at regular periods of time (one week) during three months. The three placements are shown in figure 3.

a b c

Figure 3. The three placements of the panels in the three environments: a – exterior aggressive environment; b – interior aggressive environment; c – environment with approximately constant parameters.

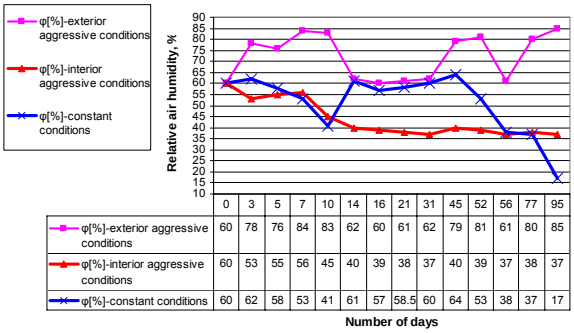
The parameters of the air (relative humidity and temperature) have varied during the three months of performing the tests as shown in figures 4 and 5.

Why choosing these kind of environments for the panels? First of all the application fields of the panels are interior arrangement and furniture. In these cases the temperature could not be lower than -20 °C and higher than +32° supposing that the furniture or panels designed for ceilings or walls covering and for the furniture are placed in a heated room or outside in a balcony, but protected of rains and snow and never in a direct contact with water. That's why the standard ageing tests are not very satisfactory for our purpose. The samples were also observed from the quality points of view: cracks appearance on the panel surfaces and edges and the panel delaminating. In order to particularly observe the panels' deformations in the three environments, an analysis of the experimental results has been done. Calculating the differences on "z" axis between the maximum value and the initial one in the nine established points of each sample, the variation of the panels flatness have been determined for the six types of samples: combination beech-beech (as a standard one) and beech-maple, beech-cherry, beech-ash, beech-oak and beech-nut wood as lignin-cellulose based panels.



Days	0	3	5	7	10	14	16	21	31	45	52	56	77
T, °C-constant conditions	20	19	18	16.5	22	23	23.5	22.5	22	23	22	16	15	19
T, °C-interior aggressive conditions	20	28	20	18	28	27	32	32	31	30	30	28	29	35
T, °C-exterior aggressive conditions	20	15	0	0	6	5	6	2	1	3	1	-6	0	-10

Figure 3. The curves of temperature in the three environments.



	0	3	5	7	10	14	16	21	31	45	52	56	77	95
φ[%]-exterior aggressive conditions	60	78	76	84	83	62	60	61	62	79	81	61	80	85
φ[%]-interior aggressive conditions	60	53	55	56	45	40	39	38	37	40	39	37	38	37
φ[%]-constant conditions	60	62	58	53	41	61	57	58.5	60	64	53	38	37	17

Figure 4. The curves of the relative air humidity in the three environments.

3. EXPERIMENTAL RESULTS

The differences between the maximum value and the initial one measured on "z" axis in the nine established points of each sample panel is named the maximum deflection and its value is represented for each sample in the next diagrams.

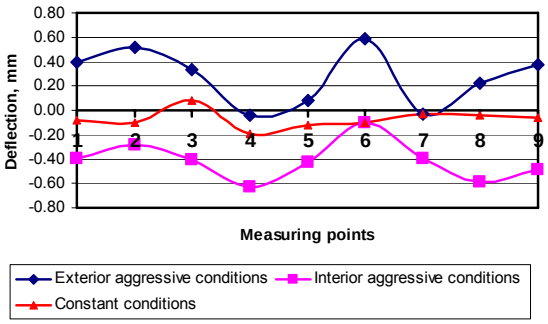


Figure 5. The maximum deflection measured in the nine points for the panel made of beech wood only.

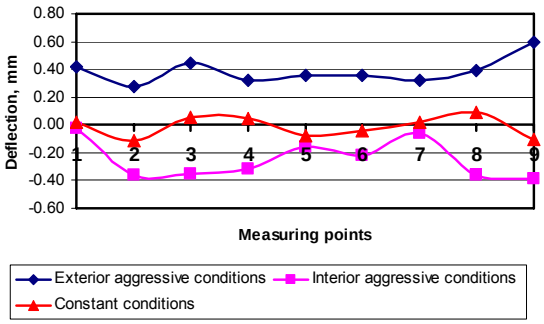


Figure 6. The maximum deflection measured in the nine points for the panel made of beech and maple wood.

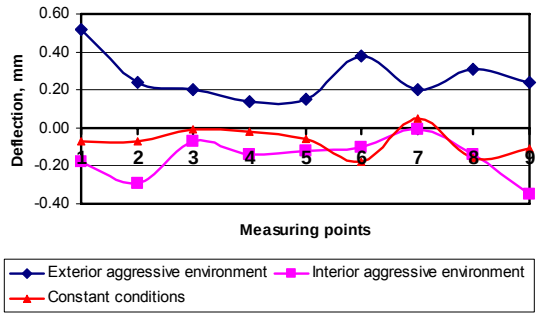


Figure 7. The maximum deflection measured in the nine points for the panel made of beech and cherry wood.

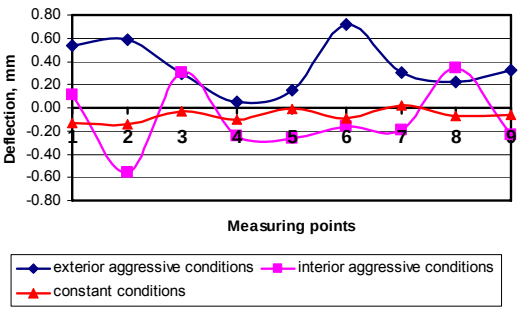


Figure 8. The maximum deflection measured in the nine points for the panel made of beech and ash wood.

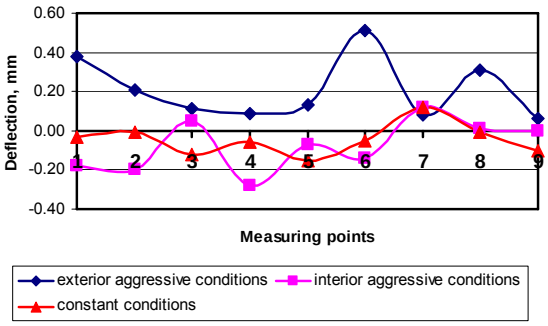


Figure 9. The maximum deflection measured in the nine points for the panel made of beech and oak wood.

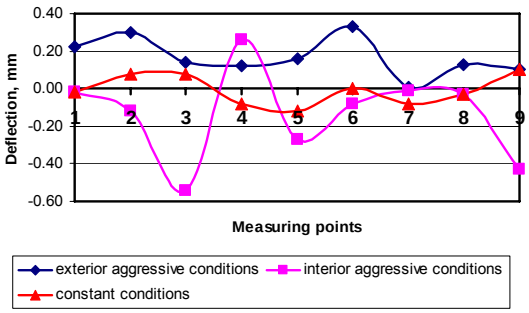


Figure 10. The maximum deflection measured in the nine points for the panel made of beech and nut wood.

4. CONCLUSIONS

The highest deformations were registered for the panels made of lamellas of beech wood and ash wood and also for those made of beech wood and oak wood. A good flatness of the panel is proved by the small variations of the "z" size in the nine points of the panel. The tendency of the curve in the graph to a parallel (as an ideal case) to the horizontal axis represents a good flatness of the panel. In the other case the deformations are high, so the flatness is unsatisfactory. The tendency as a parallel to the "x" axis can be observed at the panels made of beech wood and maple wood in the three environmental conditions and that means they had a good flatness. High variations can be observed in the cases of beech-ash wood and beech-oak wood combinations.

a **b** **c**

Figure 11. Cracks and delaminating appeared during the observation time of three month for the panels subjected to aggressive environmental condition; a- Delamination of the panel made of beech and nut wood placed in the exterior environment; b - Delamination of the panel made of beech and ash wood placed in the exterior environment; c - Delamination of the panel made of beech and nut wood placed in the exterior environment .

The theoretical conclusions obtained processing the data base of the experimental work during the three months of measuring operations were confirmed by the defects appeared on the panels were the deformations proved to be higher than for the other panels and they are: panels made of beech and ash wood, beech and oak wood and beech and nut wood. The stresses in that panels are proved to be high enough to produce cracks and delaminations of them. The best variants of lignin-cellulose based panels made of mixed hardwood are beech-maple wood and also beech-cherry wood.

5. REFERENCES

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