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EFFECT ON INDICES wood memory effect

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The results of the study of the effect of woody species on shape memory effect indicators wood. A quantitative assessment of this effect and comparisons of certain wood species and types of veneer. The possibility of the influence of the chemical composition of wood on wood performance memory effect.

Shape memory wood, measurement memory effect, frozen deformation, wood, chemical composition of wood.

The effect of memory on wood deformation transformation was experimentally discovered in the late 70s [9,15]. Further studies of various aspects of this phenomenon were mainly qualitative in nature [2,5,14]. To quantify this dominant features of wood as a natural material wise, indicators were used [8] used for polymers with shape memory [11]: R_r - The proportion of circulating strains, showing the ability of a material to memorize permanent form and is a measure of recovery deformation resulting from the mechanical action; R_f - The proportion of fixed (set) strains, which reflects the ability of a material to fix the mechanical deformation and thus remember temporary form.

At the core memory effect wood are zmorozheni strain were detected experimentally in the early 60's of the last century during drying fixed sample [4]. Frozen deformation result from temporary reconfiguration nanostructures wood under the influence of a controlled load in the event of an increase in stiffness of wood in the process of drying or cooling [14], and disappear when wet or heated. Following the model hygrom (thermo) -mehanichnyh strain wood [5.14], which was developed based on an integrated wood Act deformation under load during changes in humidity and temperature [9,16], taking into account the formation of quasi

Frozen residual strain can be obtained expressions for performance R_r and R_f.

The proportion of circulating strains R_r generally defined as follows:

$$R_r = \frac{\varepsilon_{evp} - \varepsilon_p}{\varepsilon_{evp}} \quad (1)$$

where - the total value hygrom (thermo) -mehanichnoyi strain - residual plastic strain εr = εc = εr$\varepsilon_{evp}\varepsilon_p$. The proportion of fixed (set) strain R_f calculated as follows:

$$R_f = \frac{\varepsilon_s}{\varepsilon_{evp}} = \frac{\varepsilon_f + \varepsilon_p}{\varepsilon_{evp}} \quad (2)$$

where ε_s - Set-deformation after unloading; ε_f - Frozen deformation. The value of frozen deformation is expressed through performance memory effect as follows:

$$\varepsilon_f = \varepsilon_{evp}(R_r + R_f - 1) \quad . (3)$$

The purpose of research. The value of performance memory effect wood R_r and R_f depends on the ratio of the components hygrom (thermo) -mehanichnoyi deformation. Features wood deformation due to difference structure of wood at the macro, meso, micro and nanoscale, chemical structure of wood components and their supramolecular structure. We study the impact of wood on performance memory effect.

Methods of research. Wood is a complex, heterogeneous, volatile, anisotropic material that has the ability to shrink and swell, so it was a method for visualization and quantification using very small samples [7]. This method allows to identify the main factors that influence eliminuyuchy above factors and identify all possible characteristics of a sample. This reduces the required number of experiments and facilitates the analysis of the data. Experimental studies were carried out on samples that are bent, planning, peeled and composite (fine-line) with wood veneer birch, beech, pine and obeche during changes in temperature and humidity (Table. 1). The range of temperature - 0 - 100 C °, Humidity - 0 - 150%.

1. Characteristics of the sample.

Breed	Type veneer	Sample Size, mm
Beech (Fagus L.)	Sliced	250 * 15 * 0.6
Pine (Pinus sylvestris L.)	Sliced	250 * 15 * 0.6

End Table. 1

Breed	Type veneer	Sample Size, mm
Obeche (Triplochiton scleroxylonK. Schum.)	Fine-line	250 * 15 * 0.6
Birch (Betula L.)	Rotary	250 * 15 * 1.5

Results. To investigate the effect of memory in the event of bending load and changes in temperature or humidity held 14 series of experiments. Figure 1 shows the results of the pilot study parameters R_r^t and R_f^t during temperature changes. It can be seen that the magnitude R_r^t along and across the grain has corresponding maximum values for samples of sliced veneer of beech wood - 0.97 and 0.78. Size R_r^t along the grain sample sliced veneer wood pine is somewhat lower (0.92) than for beech wood. Direction indicator across the grain R_r^t sample of pine also has a smaller value (0.54) that in addition to the above reasons, due to the presence of existing prior to the experiment drying cracks.

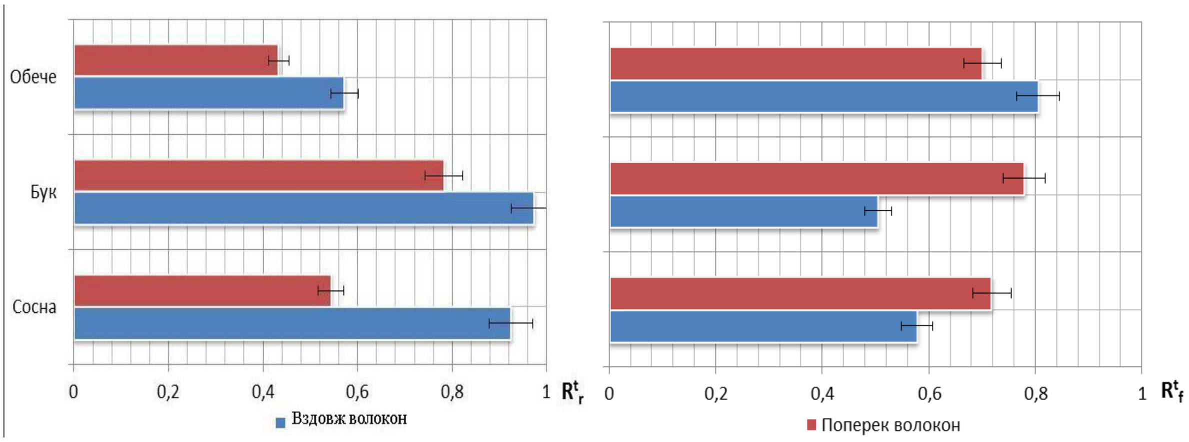

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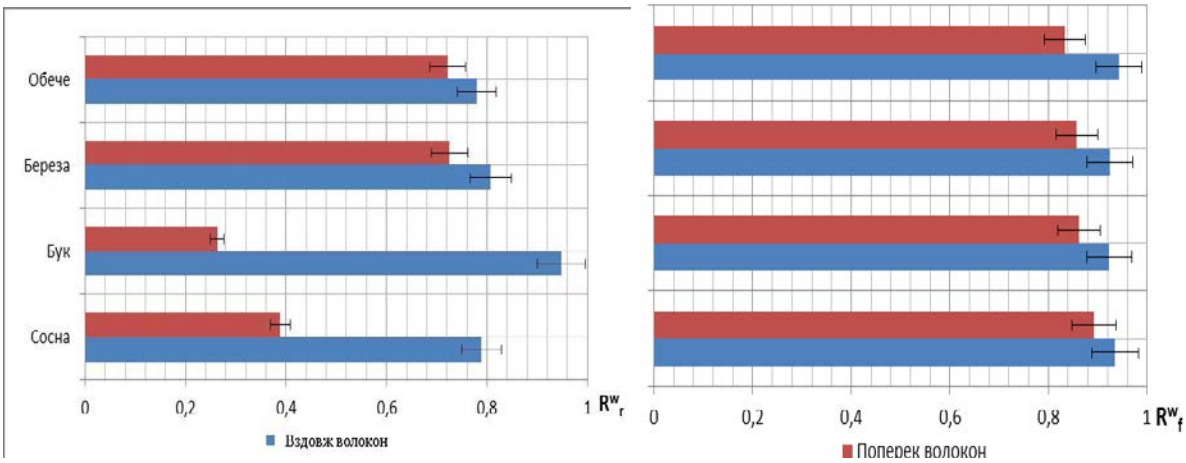
Fig. 1. Indicators memory effect wood R_r^t (A) and R_f^t (B) during temperature changes.

The value of the index R_f^t In the direction across the grain has a maximum value for beech wood (0.78). Size R_f^t sample sliced veneer wood pine and composite wood veneer obeche is respectively 0.72 and 0.70. Towards along the fibers most important R_f^t obtained for samples of composite wood veneer obeche (0.81) .Zrazky sliced veneer wood pine indicators are higher than for beech wood (0.58 and 0.50, respectively), as the strength and stiffness of wood pine lower than in wood beech.

Fig. 2 shows the effect of memory performance for different types of veneer during changes in humidity.



a b

Fig. 2. Indicators memory effect wood R_r^w (A) and R_f^w (B) changes in the humidity.

The value of the index R_r^w in the direction along the fibers in the maximum beech (0.95). The value of R_r^w across the grain sample sliced veneer of beech wood less than pine wood (0.26 and 0.39, respectively). This is due to the influence of broad medullary rays beech, drying fabrics gap occurs along the medullary rays through the weak link with the wood fibers. Towards across the grain index R_r^w sample peeled veneer birch wood and fine-line veneer wood obeche has similar values (0.72 and 0.72) that in addition to the above reasons, due to the presence shelling cracks on the surface of the veneer and multi-processing fine-line veneer. The value of the index R_f^w in the direction along the fiber for all breeds and types of veneer has about the same value $R_f^w \geq 0{,}9$ (0,92-0,94). Towards across the grain, there is also quite high rates R_f^w (0,83-0,89).

Previously, we have conducted experimental studies memory effect during changes in temperature and humidity on a massive birch wood [2,14]. Based on L. Salmén [13], we have been suggested [2] that the changes occurring in the lignin-hemitselyulozniy matrix and amorphous (non-crystalline) areas cellulose. In the wood for the higher humidity saturation limit cell walls and at room temperature not only hemicellulose, but also all amorphous (non-crystalline) areas in cellulose are highly elastic state. This explains the emergence of large strains, some of which are irreversible.

In our further trials, conducted in conjunction with YFTT RAS [6] by IR spectroscopy has been shown to dry birch wood loaded led to a change in the first place, the amorphous areas cellulose, and the system of hydrogen bonds wood. This restructuring is in the process of cooling the loaded timber. This will play a major role concentrations of hydrogen bonds.

In [10] put forward the assumption that hemicellulose and lignin control mechanism memory effect wood. Hemicellulose mechanism responsible for fixing the form (R_f) And lignin - the restoration of the form (R_r). However, this assumption is controversial nature and requires further research.

Below are data on the chemical composition for the tree (Table. 2).

2. Composition of basic organic compounds trees,%

Breed	Lignin	Cellulose	Hemicellulose	Source
Beech	22.7	45.4	22.2	Molnar S., Bariska M. [11]
	11,6-22,7	33,7-46,4	17,8-25,5	Wagenfuhr R., Scheiber Chr. [16]
	20.8	46	36.9	Nikitin NI [3]
Pine	26,9-28,2	53.8	20.5	Nikitin NI [3]
	29.5	41.9	21.5	Molnar S., Bariska M. [11]
	25,4-29,4	39,7-57,1	7,9-11,2	Wagenfuhr R., Scheiber Chr. [16]
Birch	21.2	45.8	26-42,0	Nikitin NI [3]
	19-20,1	45,3-48,6	27.8	Wagenfuhr R., Scheiber Chr. [16]
Obeche	32,3-34	41,1-47,6	15,5-17,5	Wagenfuhr R., Scheiber Chr. [16]

Results of the study of the chemical composition is often impossible to compare because of differences in methods of separation and determination of the components of woody substances of natural variability. It is known that wood of conifers is more lignin content and heksozaniv in hardwood hemicellulose prevail among pentozany [1]. Studies have shown that different composition of lignin in wood of beech and pine insignificant value displayed on the indicator R_r^t in the direction along the fibers. Towards across the grain fraction of circulating and fixed deformities is higher in beech that may be associated with a higher content of hemicellulose. When changing the temperature and humidity loads occur reversible changes in supramolecular structure of wood components that contribute to the effect of "memory" of wood. Due to the amorphous nature hemicellulose are highly sensitive to temperature and moisture action. Therefore, the effects observed, increasingly found in hardwood.

For a more detailed analysis of the impact of wood on performance memory effect, it is necessary to identify patterns of deformation sample sliced veneer of beech wood and pine. Despite the significant differences in the structure and chemical composition of these rocks, the value of the modulus of elasticity in bending along the grain beech and pine [1] for the normalized humidity is approximately the same and is 12.4 and 12.2 GPa, respectively.

Shares components hihromehanichnyh heat and deformation of wood in the direction along and across the fibers shown in Fig. 3 and Fig. 4. Shares set-strains that determine the value of fixed strain while changing moisture wood in the direction along and across the grain for beech and pine are practically identical. For thermomechanical deformation, the difference is greater. The structure of set-deformations are quasi-irreversible deformation frozen and irreversible plastic deformation. Towards along the grain size determine the set-strain deformation frozen. Towards across the grain pattern significantly hampered by frozen drying. In addition, the presence of broad medullary rays in beech lead to large plastic deformations. The magnitude of the elastic elastic deformation chilled or dried wood εev2 is almost the same as modulus of elasticity of beech and pine are roughly equal size.

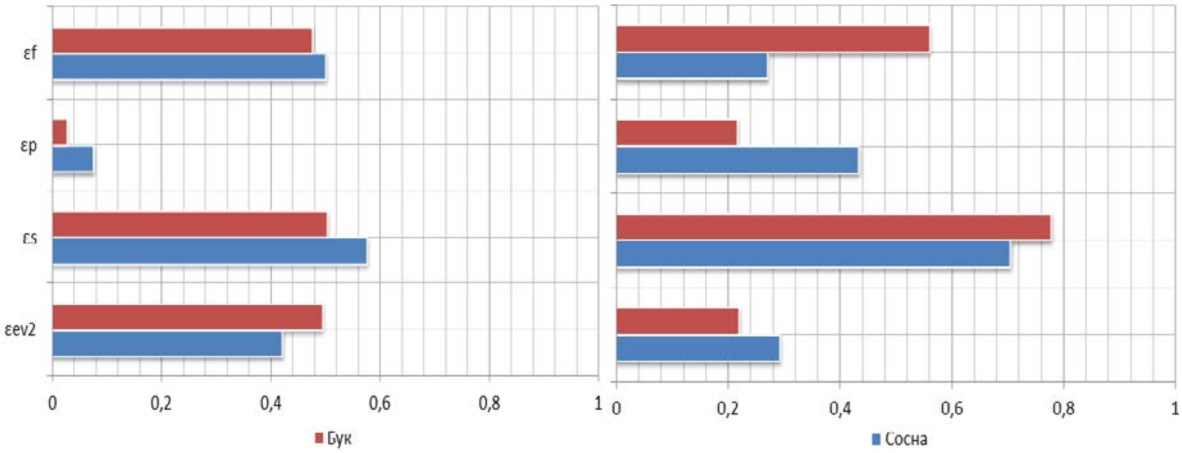


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Fig. 3. Shares thermomechanical deformation along the wood (s) and across the grain (b).

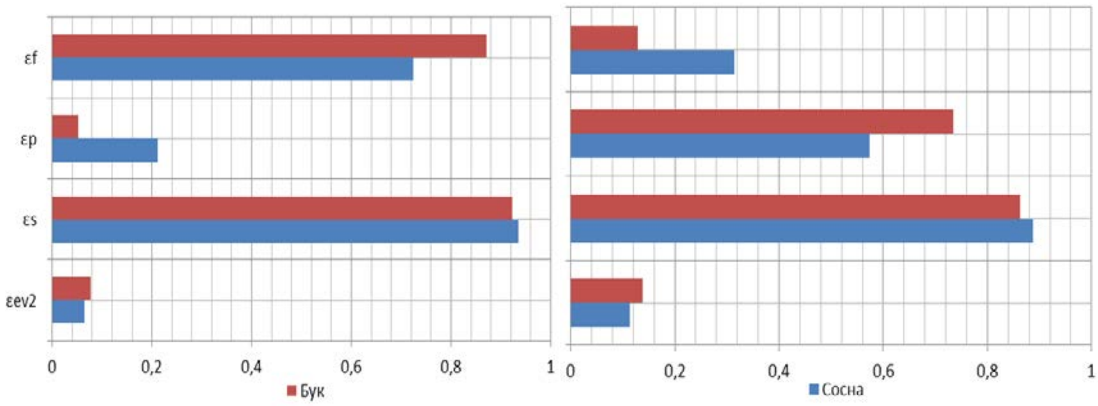

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Fig. 4. Shares hihromehanichnoyi deformation along the wood (s) and across the grain (b).

Conclusions

1. The complexity of the structure, chemical composition, anisotropy, natural variability properties of wood leads to certain difficulties in the objective assessment of memory effect of different wood species. The proposed method can detect the basic regularities of woody species on performance memory effect wood.

2. Features veneer manufacturing techniques carry a greater impact on performance memory effect than wood.

3. For samples of sliced veneer pine and beech indicators R_r^t and R_f^t in the direction along the fibers and index R_f^w in the direction along and across the fibers have almost the same value. The remaining parameters memory effect wood has a greater impact.

4. A more detailed examination of the formation mechanism of fixed deformities should take into account that fixed deformation includes not only reversible elastic-elastic and plastic deformations and irreversible. Given the two-component composition fixed deformation, it is advisable to find out deformation behavior of the main chemical components.

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Results of the study of influence Pryvedenы drevesnoy porodы indicators on the effect of memory forms timber. Conducted kolychestvennaya evaluation of the effect and эtoho Comparison indicators for timber species and breeds nekotorыh veneer. Rassmotrena Possibility of influence the chemical composition of wood on the effect indicators Storage timber.

Effect Storage timber forms, kolychestvennaya evaluation of the effect of memory, zamorozhennaya deformation, drevesnaya breed composition himicheskij timber.

Results of experimental research of influence of wood species on quantities of memory effect were presented. The quantitative assessment of memory effect, comparison of quantities for some wood species and types of veneer were experimentally investigated. The data on effect of chemical composition of wood on parameters of memory effect wood also are presented.

Shape memory effect of wood, a quantitative assessment of memory effect, frozen strain, wood species, chemical composition of wood.

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DEFINITION QUALITY TIMBER surfaced

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