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ANALYSIS OF OPERATING ABILITIES OF DIFFERENTWOOD BREEDS BEING OPERATED OUT-OF-DOORS

The article presents the study results of operating abilities of ash, pine and spruce wood, of antiseptized spruce and thermo-modified wood. The researches made have shown that as a result of wood thermo-modification the absorption of water and moisture reduces by 20–50%, shrinkage of wood decreases and thus its stability of shape increases, wood strength properties decrease: ability to hold the mount across the fibers decreases by 10–50%, along the fibers – by 30–50%, chipping resistance along the fibers decreases by 20–50%.

Introduction. Wood is a natural, ecological, renewable material with a wide spectrum of colour gamma and texture. It has low volume weight, high strength, it is easily processed. All it has caused a wide usage of the given material in all industries and national economy.

While using wooden structures and sheathing elements out-of-doors they are exposed to constant influence of destroying climatic and biological factors. Ultra-violet radiation, daily and seasonal fluctuations of temperature and air humidity, influence of atmospheric precipitation, wind gusts and etc. are the main climatic wood-destructive factors.

Recently manufacturers recommend using thermo-modified wood (TMW) for production of structures and sheathing elements to be used out-of-doors. Wood thermo-modification is a special technology of thermal processing intended to give it an additional strength, stability of geometrical dimensions, resistance to environment influence.

Main part. Various wood breeds have different resistance to destroying environment influences, besides resistance can vary within one breed because of growing conditions and also depending on the cut position in the log section.

To study and compare the operational properties of wood used to manufacture products serving in the conditions of the atmospheric environment, samples of the most widespread in the conditions of Belarus coniferous breeds of pine, spruce and of ash-tree were selected.

While used out-of-doors the non-protected wood darkens quickly and is exposed to influence of biological wood-destructive factors (affection by fungi, insects and microorganisms). The most widespread methods of increase of wood resistance to external influences are its processing by protective compounds (fire-retarding agents, antiseptics, paints, oils, etc.). In this connection samples of antiseptized spruce were selected for tests and also samples of the above mentioned breeds thermo-modified in the steam-air environment at different temperature modes.

Wood is a hygroscopic material and in the conditions of variable air humidity and precipitation influence the humidity of wood used out-of-doors fluctuates in wide ranges causing constant change of the linear dimensions and wood volume. These fluctuations lead to occurrence in wood of internal stress, its checking, to unfastening of fastening elements, etc.

To determine hygroscopic properties of wood samples and their stability of shape tests to find out water absorption (STATE STANDARD 21523) [1], moisture absorption (STATE STANDARD 16483) [2], and also shrinkage in radial and tangential direction (STATE STANDARD 16483) [3] were conducted, the results of which are given in Table 1.

From the data given in the Table it is clear that moisture equilibrium of the check samples of all breeds and antiseptized wood at temperature of 18°C and relative air humidity of 65% is approximately equal and makes about 7–8%. Moisture equilibrium of the wood thermo-modified in the steam-air environment under the same conditions is considerably lower and fluctuates within 2.5–4%, and the lower the moisture equilibrium is the higher the temperature is at which modification was done.

The same tendency of parameters change is observed in the water absorption and moisture absorption data. At wood thermo-modification the samples stability of shape increases, i.e. shrinkage and swelling of wood both in radial and in tangential direction decrease.

Strength properties of wood are of great importance at designing and manufacturing of finished goods from it. Such properties are chipping strength along fibres, static bend strength, and also ability to hold nails and other metal fastenings.

Many from the listed strength properties depend on density, humidity and anatomic structure of wood.

While manufacturing products from wood and wood materials the wood screws are widely used as fastening elements. Tests were conducted according to STATE STANDARD 16483.33–77 [4] to study the ability of check samples and samples of thermo-modified wood to hold fastenings.

Table 1

Research tests results of hygroscopic properties of the check samples of pine, spruce, ash-tree, spruce antiseptized and thermo-modified wood

Sample	Moisture equilibrium at t = 18°C, φ = 65%	Moisture absorption, %	Water absorption, %	Shrinkage, %, in direction	
				radial	tangential
Ash-tree					
Check sample	6.2	33.11	118.94	5.5	9.5
TMW at t = 180°C	4.0	26.39	107.73	5.3	6.5
TMW at t = 200°C	2.8	20.63	74.86	3.7	5.1
TMW at t = 220°C	2.4	15.14	69.82	2.9	3.7
Spruce					
Check sample	7.7	48.97	204.46	4.6	5.9
TMW	2.7	34.43	180.52	2.7	5.2
Antiseptized	7.9	15.06	155.07	4.1	5.7
Pine					
Check sample	7.8	36.05	91.14	6.2	6.0
TMW at t = 180°C	5.5	23.95	62.16	5.3	8.1

Strength index researches at the static bend were done on small samples, according to the technique [5]. The samples dimensions were 7×7 mm in section and 100 mm of length. Besides wood strength at the static bend the modulus elasticity was defined.

Strength researches of wood chipping along fibres were done according to STATE STANDARD 16483.5-73 [6]. Strength tests results are given in Table 2.

As it is clear from Table 2 the ability of wood to hold fastenings at thermo-modification decreases on 30–60% along and across fibres, chipping strength along fibres also decreases on 20–50% in relation to the check samples. Thermo-modified wood strength at the static bend decreases to a lesser degree (on 5–15%).

Conclusion. As a result of the analysis of data received while doing research of wood samples of various breeds (pine, spruce and ash-tree), antiseptized wood and wood thermo-modified in the air environment, the following regularities are established:

1. Water absorption and moisture absorption decrease in pine samples on 30%, in spruce samples – 15–30%, in ash-tree samples – 20–50%, wood shrinkage decreases and its stability of shape increases accordingly. The difference between the similar indexes for the wood check samples of spruce and spruce antiseptized is insignificant.

2. Wood strength properties decrease: ability to hold fastenings across fibres: for pine samples – on 50%, for spruce samples – 10%, for ash-tree samples – 13–30%, along fibres: for pine samples – on 54%, for spruce samples – 5.6%, for ash-tree samples – 30–40%; chipping strength along fibres decreases on 20–50%.

The research results analysis of properties of the wood thermo-modified in the steam-air environment has shown that despite the improved hygroscopic properties the considerable decrease of strength properties limits its usage for manufacture of structures and elements bearing considerable loads.

Table 2

Research tests results of strength indexes of the check samples of pine, spruce, ash-tree, spruceantiseptized and thermo-modified wood

Sample	Sample-shu-midity, %	Specific resistance of wood to wood screws pulling P_{sp}, MPa		Chipping wood strength along fibers, σ, MPa	Static bend strength, MPa		Modulus of elasticity, GPa	
		across fibers	along fibers		σ_w	σ_{12}	E_w	E_{12}
Ash-tree								
Check sample	6.2	213.7	207.0	14.00	114.4	87.83	10.5	9.9
TMW at t = 180°C	4.0	185.8	142.0	10.69	130.6	88.83	13.0	12.0
TMW at t = 200°C	2.8	158.6	133.5	8.63	112.6	71.14	14.8	13.6
TMW at t = 220°C	2.4	154.1	129.5	7.58	97.0	60.13	14.0	12.8
Spruce								
Check sample	7.6	72.2	64.9	5.85	63.4	52.2	5.1	4.9
TMW	2.7	64.0	60.0	3.52	73.6	61.3	7.4	7.1
Antiseptized	7.8	68.0	63.0	5.64	93.9	59.0	10.1	9.3
Pine								
Check sample	7.8	155.7	140.1	9.47	121.9	101.4	9.8	9.42
TMW at t = 180°C	5.5	74.2	64.2	4.49	100.8	74.2	9.8	9.21

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