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DETERMINING THE VALUE OF CONIFEROUS WOOD DRYING USED IN DRY, HOT CLIMATE

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Annotation
The article shows indicators of wood shrinkage coefficients, drying stages, the effect of wood shrinkage density.

Keywords: sorption, vapor permeability, additive, solution, aggressive environment, shrinkage, swelling, thermal conductivity.

Introduction

Wood as a building material has been used since ancient times, the use of wood as the main load-bearing and enclosing structures of buildings and structures allowed its number of positive properties, ease of processing and transportation, significant strength and elasticity with a relatively small mass. Ensuring the reliability of wooden structures and products largely depends on its physical and mechanical properties, which include the following characteristics: density; thermal expansion; thermal conductivity; chemical and mechanical resistance, as well as a change in its size depending on humidity (shrinkage and swelling) [3-7].

In a growing tree, moisture is necessary for its life and growth; in felled wood, the presence of moisture is undesirable, as it leads to a number of negative phenomena.

Wood has a pronounced anisotropic structure. This means that properties manifest themselves differently in different directions. All cells that make up a tree differ in size in transverse and longitudinal sections. Microfibrils located in the cell membrane are located along the axis of the cell, and moisture occupies the space between them. For this reason, when moisture is removed, the transverse dimensions in the radial and tangential directions change significantly. It should be noted that in the tangential direction, that is, when cut along the fibers tangentially to annual rings, wood shrinkage is 1.5-2 times higher. The shrinkage value is expressed as a percentage of the original size.For this purpose, the materials of both the authors and other researchers were analyzed [1-14]. The essence of the analysis was to compare the results of the shrinkage value and the actual volume of wood used in our region.

Depending on the number of water molecules removed, wood shrinkage is considered as:

Full. It manifests itself with the complete evaporation of the entire amount of moisture from the structural fibers of the tree. At the same time, its moisture content decreases from the upper values of the hygroscopicity limit to zero. Under the limit of hygroscopicity in this case, it is customary to understand the maximum moisture content of the material.
Volumetric. It manifests itself in a decrease in the volume of wood during the evaporation of interconnected water particles.

Fig.1. General appearance of shrinkage and swelling.

The degree of shrinkage and swelling for each type of wood is individual. This is due to the peculiarities of the microscopic structure and chemical composition of wood fibers. Representatives of conifers have vertical and horizontal resin passages in the fiber structure. This significantly distinguishes them from hardwoods, the structure of which is represented by developed conducting vessels.

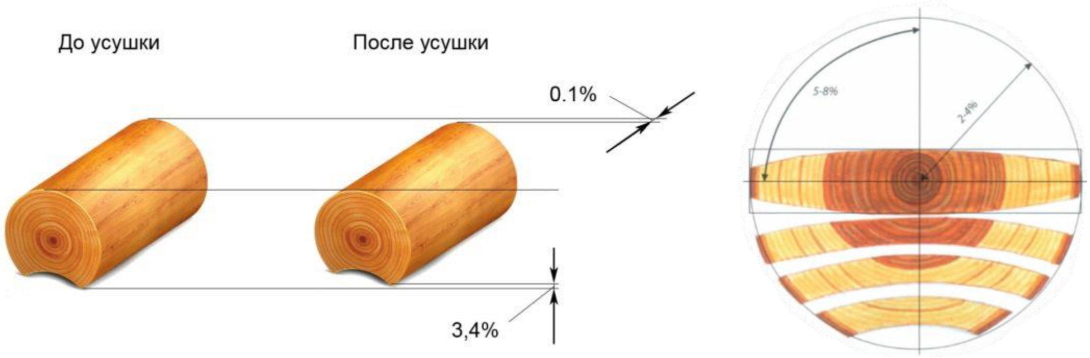

Fig. 2. Increase in size (swelling) and shrinkage.

Determining the nature and type of shrinkage usually occurs in the laboratory. A sample of the material is placed in water until completely saturated. Then the dimensions are measured using special tools - a micrometer or caliper. After that, the samples are dried to a completely dry state in an oven, and their linear dimensions are measured again.

These tests are necessary in determining the index characterizing the degree of expansion and contraction of wood fibers under physical influence.

Humidity (absolute) wood is the ratio of the mass of moisture found in a given volume of wood to the mass of abaolyuto dry wood, expressed as a percentage:

$W = [(m^1 - m^2)/m^2]100\%$,

where W is wood moisture content, %; m1 is the weight of the wet wood sample, g; m2 is the mass of a sample of absolutely dry wood, g.

In practice, moisture is determined by the method of drying and electrical moisture meters.

In wood, moisture is bound (hygroscopic) and free (capillary). Free moisture fills cell cavities and spaces between cells, while bound moisture permeates cell walls. Free moisture from wood is easily removed, the removal of bound moisture requires additional energy[20-26].

When the wood dries, moisture evaporates from the surface of the assortment and moisture from the wetter inner layers moves to the outer, less humid layers. Thus, uneven distribution of moisture over the thickness of the material is observed. The greater the thickness of the material, the greater the uneven distribution of moisture.Drying speed depends on meteorological conditions, laying methods and type of assortment. Warm, dry weather speeds up drying. Short and thin lumber dries faster than long and thick lumber.

Shrinkage is a decrease in the linear dimensions and volume of wood during drying. Shrinkage begins from the moment when all free moisture evaporates from the wood and the bound moisture begins to be removed, i.e. by reducing the moisture content of wood from the limit of hygroscopicity (30%) to a completely dry state. Shrinkage of wood in different directions is different. On average, complete linear shrinkage in the tangential direction is 6-10%, in the radial direction 3-5% and along the fibers 0.1-0.3%. The decrease in the volume of wood during the evaporation of bound moisture is called volumetric shrinkage. Total volumetric shrinkage is 12.0-15.0% depending on the type of wood. Therefore, when sawing raw logs into boards, allowances for shrinkage are provided so that after drying, the lumber and blanks have the specified dimensions.

Due to the heterogeneity of the structure of wood, its shrinkage and swelling are not the same in different directions. Shrinkage in the direction of annual layers, the so-called tangential shrinkage, gives the greatest value. It reaches 8-12%> when all moisture is removed. For example, a board 100 mm wide, sawn from the side of a log and dried to a completely dry state, will decrease in width to 88-92 mm.Shrinkage in the direction of the radius of the trunk, called radial, is 5-8%, and in the direction of the length of the wood fibers (along the axis of the trunk), called longitudinal, is only 0.1%. In practice, longitudinal shrinkage is never taken into account.

Volumetric shrinkage, i.e. the decrease in the volume of a wood sample during drying is approximately equal to the sum of tangential and radial shrinkage and ranges from 12 to 20%.

Dense hardwoods give large shrinkage values, while softwoods and soft hardwoods give less[1-9].

Consider the coefficient of shrinkage and swelling for different types of wood.

Shrinkage coefficients Ku and swelling Kp

Breed Larch	**Shrinkage and swelling coefficients in the direction**					
	Volume		**Radial**		**Tangential**	
	K_y	K_p	K_y	K_p	K_y	K_p
Pine	0,52	0,61	0,19	0,20	0,35	0,39
Cedar	0,44	0,51	0,17	0,18	0,28	0,31
Birch	0,37	0,42	0,12	0,12	0,26	0,28
Beech	0,54	0,64	0,26	0,28	0,31	0,34
Ash	0,47	0,55	0,17	0,18	0,32	0,35
Oak	0,45	0,52	0,18	0,19	0,28	0,35
Aspen	0,43	0,50	0,18	0,19	0,27	0,29
Breed	0,41	0,47	0,14	0,15	0,28	0,30

All tree species have a different shrinkage coefficient and, depending on its value, are formed into groups:

- shrinkage in volume does not reach 0.40% - weeping spruce, Caucasian fir, poplar, common ash.
- shrinkage from 0.40% to 0.47% - European or forest beech, elm, oak, heart-shaped linden, alder;
- shrinkage is manifested by more than 0.47% - birch, European larch, Norway maple.

The value of the shrinkage coefficient helps to predict the probability of occurrence of internal stresses and cracking as a result of uneven evaporation of moisture and take measures to prevent their occurrence.

Standardization plays an important role in improving production efficiency and product quality, the definition of which is given in GOST 10-68. Standard, a normative and technical document on standardization that establishes a set of norms, rules, requirements for the object of standardization and approved by the competent authority.

The dimensions of the assortments indicated in the standards at the established moisture content of the wood are usually called nominal[10-19].

Shrinkage allowances for softwood lumber are established by GOST 6782.1-75, for hardwood sawn timber - GOST 6782.-2-75, for mechanical processing of sawn softwood and hardwood products - GOST 7307-75, The shrinkage allowance value ensures the preservation of the nominal dimensions of lumber in terms of thickness and width. For example, it is necessary to find the shrinkage allowance for a spruce board 50 mm thick and 150 mm wide with an initial moisture content of more than 37% and a final moisture content of -15%, according to GOST6782.1-75 (ST SEV1148-78) table.1 shrinkage value for spruce boards with a nominal thickness of 50 mm and a width of 150 mm at an initial moisture content above 37% and a final -15% is equal to 2.0 and 5.2 mm, respectively; Another example is to find the actual dimensions of mixed sawn pine boards shipped with moisture above 37%. The nominal dimensions of the boards at a humidity of 15% should be: thickness 50 mm, width 150 mm. According to

GOST6782.1-75 (ST SEV1148-78) tab. 3 values of shrinkage of pine boards at a moisture content above 37% for a nominal thickness of 50mm and a width of 150mm are respectively plus 2.0 mm and plus 5.2 mm. The desired actual dimensions of the boards are: thickness 50.0 +2.0 = 52 mm; width 150.0+ 5.2 = 155.2 mm.

GOST 6782.1-75 (st sev 1148-78). "Sawn products from coniferous wood. The amount of shrinkage. This standard applies to sawn softwood products of tangential, radial and mixed cuts and establishes the shrinkage value in terms of thickness and width to ensure the nominal dimensions of sawn products [15-26].

The actual dimensions of the thickness and width of sawn products at a moisture content exceeding that established for the nominal dimensions should be larger, and at lower moisture content they may be less than the nominal dimensions by the corresponding shrinkage value.

Nominal sizes of sawmills are established by the standards of technical requirements for specific types of products at a moisture content of 15 or 20%. The moisture content of lumber is determined according to GOST 16588. The amount of shrinkage of sawn lumber of mixed sawing (with a tangential-radial direction of annual layers) for a final moisture content of 5 to 37% is set according to tables 1 and 2 of this standard[20-26].

In one example, consider the amount of shrinkage and the actual volume of wood used in our region. According to the documents received, the moisture content of lumber at the time of receipt was more than 37%, and at the time of sale from 14-16% (for spruce, pine, cedar and fir wood) and 20% for larch wood (given that Fergana belongs to dry and hot climate) we recommend determining the actual cross-section of boards depending on the thickness of 40 mm and 50 mm, and the width from 100 to 300 mm for spruce, pine, cedar and fir wood according to table 1 and for larch wood according to table 2, GOST 6782.1- 75 (ST SEV 1148-78).The methodology for calculating the actual volume of sawn timber due to shrinkage is given below in the text: if the thickness of sawn timber is c.p. (spruce, pine, cedar, and fir) is 40 mm, then its shrinkage at an initial moisture content of 37% and a final moisture content of 15% in thickness according to table 1 GOST6782.1-75 is 1.6-0.2 = 1.4 mm ; and with a nominal thickness of 50 mm is 2.0-0.3=1.7 mm; with a board width of 100 mm, shrinkage is 3.7-0.6 = 3.1 mm; with a board width of 150 mm, 5.2-0.8 -4.4 mm; with a board width of 200 mm, 6.7-0.9 = 5.8 mm; with a board width of 250 mm, 8.4-1.2 = 7.2 mm; with a board width of 300 mm, 9.3-1.5 = 7.8 mm. The actual size of the cross-section of a board with a nominal size of 40x100 mm, taking into account shrinkage, is A1 = 38.6 x 96.9 mm. If to calculate 1 m3 of volume with a length of 1 pm boards, 1000/40=25 boards are required for the height of the stack and 1000/100 = 10 boards for the width, then the actual volume can be calculated as follows:

Vf = A1 x25x10 = 0.0386x0.0969x25x10 = 0.93508 m3, for 100 m3 Vf = 0.93508x100 = 93.508 m3.

Conclusion

As can be seen from these simple calculations, the correct accounting for wood shrinkage is important both when calculating the wooden structures of buildings, and when calculating the volume of products, lumber.

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