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Determining the Value of Coniferous Wood Drying

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Abstract: The article shows indicators of wood shrinkage coefficients, stages of shrinkage, the effect of wood shrinkage density.

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

Introduction. Wood has been used as a building material since ancient times, the use of wood as the main bearing and enclosing structures of buildings and structures has 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).

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.

The wood has a pronounced anisotropic structure. This means that properties manifest themselves in different ways in different directions. All the cells that make up the tree differ in size in cross-section and longitudinal section. Microfibrils located in the cell membrane are located along the cell axis, and moisture occupies the space between them.

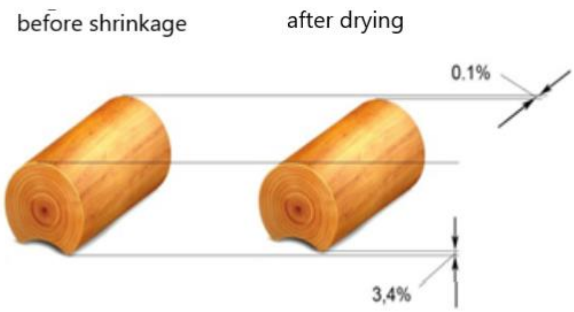
For this reason, when moisture is removed, the transverse dimensions in the radial and tangential directions change significantly. It should be canceled that in the tangential direction, that is, when cutting along the fibers tangentially to the growth rings, wood shrinkage is 1.5-2 times higher. The amount of shrinkage is expressed as a percentage of the original size. For this, 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 removed water molecules, wood shrinkage is considered as:

Complete. 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.

The degree of shrinkage and swelling is individual for each wood species. 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 deciduous species, the structure of which is represented by developed conducting vessels.



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

These tests are necessary to determine the index characterizing the degree of expansion and contraction of wood fibers under physical stress.

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

$W = [(m_1 – m_2)/m_2]100\%$,

where W - wood moisture,%; m1 is the mass of a wet wood sample, g; m^2 is the mass of a sample of absolutely dry wood, g.

In practice, humidity is determined by the drying method and electrical moisture meters. In wood, there is a distinction between bound (hygroscopic) and free (capillary) moisture. Free moisture fills cell cavities and spaces between cells, while bound moisture permeates the cell walls. Free moisture from wood is given easily, removing bound moisture requires additional energy.

When the wood dries, moisture evaporates from the surface of the assortment and moisture from the more humid inner layers moves to the outer less moist layers. Thus, there is an uneven distribution of moisture over most of the material. 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 timber dries faster than long and thick timber.

Shrinkage is the reduction in the linear dimensions and volume of wood during drying. Shrinkage begins from the moment when all free moisture evaporates from the wood and bound moisture begins to be removed, i.e. with a decrease in the moisture content of wood from the hygroscopicity limit (30%) to an absolutely dry state. Wood shrinkage 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 length of the fibers 0.1-0.3%. The decrease in the volume of wood with the evaporation of bound moisture is called volumetric shrinkage. Full volumetric shrinkage is 12.0-15.0%, depending on the type of wood. Therefore, when cutting raw logs into boards, allowances for shrinkage are provided so that after drying, the lumber and workpieces have the specified dimensions.

Due to the heterogeneity of the structure of wood, its shrinkage and swelling are not the same in different directions. The greatest value is given by shrinkage in the direction of annual layers, the so-called tangential. It reaches 8-12% when all moisture is removed. For example, a board 100 mm wide, cut from the side of a log and dried to an absolutely dry state, will decrease in width to 88-92 mm. Shrinkage in the direction of the trunk radius, 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%. Almost longitudinal shrinkage is never considered. Volumetric shrinkage, i.e. the decrease in the volume of a wood sample upon drying is equal to approximately the sum of tangential and radial shrinkage and ranges from 12 to 20%. Dense hardwoods produce higher shrinkage values, while softwood and softwoods produce lower shrinkage values.

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

Coefficients of shrinkage K_y and swelling K_p

Breed	Shrinkage and swelling coefficients in the direction					
	Volumetric		Radial		Tangential	
	K_y	K_p	K_y	K_p	K_y	K_p
Larch	0,52	0,61	0,19	0,20	0,35	0,39
Pine	0,44	0,51	0,17	0,18	0,28	0,31
Cedar	0,37	0,42	0,12	0,12	0,26	0,28
Birch	0,54	0,64	0,26	0,28	0,31	0,34
Beech	0,47	0,55	0,17	0,18	0,32	0,35
Ash	0,45	0,52	0,18	0,19	0,28	0,35
Oak	0,43	0,50	0,18	0,19	0,27	0,29
Aspen	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 manifests itself by more than 0.47% - birch, European larch, Norway maple.

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

In increasing production efficiency and product quality, standardization plays an important role, the definition of which is given in GOST 10-68. A standard, a normative and technical document on standardization, establishing a set of norms, rules, requirements for an object of standardization and approved by the competent authority.

The dimensions of the assortments indicated in the standards at the established wood moisture content are usually called nominal.

Allowances for shrinkage of sawn softwood are set by GOST 6782.1-75, for sawn hardwood, GOST6782.-2-75, for machining sawn softwood and hardwood, GOST 7307-75. and width. For example, it is necessary to find the amount of allowance for shrinkage of spruce boards with a thickness of 50 mm and a width of 150 mm with an initial moisture content of more than 37% and a final moisture content of -15%. 50 mm thick and 150 mm wide with an initial moisture content above 37% and a final -15% moisture content equal to 2.0 and 5.2 mm, respectively; Another example is to find the actual dimensions of mixed sawn pine planks supplied with moisture content above 37%. The nominal dimensions of the boards with a moisture content of 15% should be: thickness 50 mm, width 150 mm. According to GOST6782.1-75 (ST SEV1148-78) table. 3 values of pine boards shrinkage at humidity 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 required 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 reason for the shrinkage. " This standard applies to sawn products from softwood of tangential, radial and mixed cuts and specifies the shrinkage value in terms of length and width to ensure the nominal dimensions of sawn timber.

The actual dimensions of the thickness and width of sawn timber with a moisture content exceeding that established for the nominal dimensions must be greater, and with a lower moisture content they may be less than the nominal dimensions by the corresponding amount of shrinkage.

The nominal sizes of pyloric products are established by the standards of technical requirements for specific types of products with a moisture content of 15 or 20%. The moisture content of sawn timber is determined according to GOST 16588. The amount of shrinkage of sawn timber with mixed sawing (with 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.

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 sawn timber 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 (considering that Fergana belongs to dry and hot climate) we recommend determining the actual cross-section of the 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: (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 it 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 A_1 = 38,6 x 96,9 mm.

If to calculate 1 m3 of volume with a length of 1 pm of a board, 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:

$V_f = A_1$ x25x10 = 0,0386x0,0969x25x10 = 0.93508 m^3, for 100 m^3 V_f = 0,93508x100 = 93,508 m^3.

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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