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STUDY OF THE FIRE RESISTANCE AND THERMOPHYSICAL PROPERTIES OF WOODEN CONSTRUCTIONS

Abstract. *The article will see some connections, it is advisable to conduct a comprehensive study of the thermophysical properties of words, taking into account the influence of temperature and humidiru factors. Recommendations are given for their use in the calculations of druing, wood impregnation and fire resistance of wooden structures.*

Key words *: fire resistance; heating engineering; thermophysical properties; specific heat capacity; heat transfer coefficient; wood moisture;*

density; according to the parabolic law; extractive substances; nodes; heat flow; along the fibers.

ИССЛЕДОВАНИЕ ОГНЕУСТОЙЧИВОСТИ И ТЕПЛОФИЗИЧЕСКИХ СВОЙСТВ ДЕРЕВЯННЫХ КОНСТРУКЦИЙ

Аннотация. *В статье рекомендуется комплексное исследование теплофизических свойств древесины с учетом влияния температурно-влажностных факторов. Даны рекомендации по сушке, пропитке древесины и их использованию при расчете огнестойкости деревянных конструкций.*

Ключевые слова: *огнестойкость, теплотехника, теплофизическая характеристика; удельная теплоемкость; коэффициент теплопроводности, слово влажность, плотность, по параболическому закону, экстрактивные вещества, бит, тепловой поток, поперек волокон.*

It is necessary to know the thermophysical properties of wood when applying the methods of drying, curing and calculating fire resistance of wooden structures, in particular, when solving the problem of thermal engineering of fire resistance. In domestic and foreign literature on the study of wood and wooden structures, there is very scattered information about the thermophysical properties of various types of wood. When calculating the fire resistance of wooden structures, different values of indicators are used, which negatively affects the reliability of the obtained calculation data.

When calculating the fire resistance of wooden structures, the relative heat capacity (C) and thermal conductivity coefficient (λ) of wood of different densities at temperatures corresponding to fire conditions are mainly taken into account, taking into account the moisture content of the wood is used.

The article discusses literature data on the values of C and λ properties of pine wood; The results of experimental determination of these properties for pine and larch are also presented.

In QMQ 2.01.04 (Heat technology in construction), pine and spruce timber in the dry state in transverse and longitudinal directions (wood density 500 kg / m3) 2.30 kJ / (kg,) heat provides strength.. With the increase of wood moisture and its temperature, C increases according to the parabolic law. Several equations have been proposed for dry wood to describe the dependence of C kJ/(kg, °C) on temperature (T, °C):

$$C=1.33+0.0046\,T \quad C=1.57+0.00277T$$

$$C=1.11+0.0049T\ (T=0+112\ ^{at\ 0}C)$$

$$C=1.11+0.0042T\ (at\ T=60\text{-}140\ ^{0}C)$$

It is noted that the average value of dry wood in the temperature range from 0 to 100 °C is 1.68 kJ/(kg, °C). An equation was proposed to determine kJ/(kg, °C) taking into account wood moisture (pH) and temperature (T, °C) $C=1.08+0.0041\,\varphi+ 0.0025T+0.00006\,\varphi T$.

A nomogram is used to determine the value of C in wood at different humidity and temperature. Using this nomogram, for example, at 12% humidity and a temperature of 20 ° C, it is equal to 2.0 kJ / (kg, ° C) in wood.

The thermal conductivity of wood depends on its moisture density, humidity and temperature, the direction of the fibers, the content of extraction substances and the presence of structural inhomogeneities (cracks, knots, etc.) in the wood.

QMQ 2.03.08-98 (Wooden constructions) T.DAQQ 1998 gives the following values of thermal conductivity coefficients in the dry state (500 kg / m^3) for pine and spruce wood transversely and along the fibers : 0.09 and 0.18 Bt / (m, °C), respectively, the equation to determine λ is proposed: $\lambda = \lambda_n K_r K_p$,where λ_n is the nominal value of λ at the given temperature and humidity;

K_r - the value of the coefficient taking into account the conditional density of wood;

K_p coefficient is a value that takes into account the direction of heat flow.

As noted, the thermal conductivity of wood in the radial direction is slightly greater than in the tangential direction to the annual layers, and in the longitudinal direction, the coefficient of thermal conductivity is significantly greater. The thermal conductivity of wood along the fibers is 1.63-2.96 times along the fibers, and in the radial direction it is on average 15% higher than in the tangential direction.

Contains comparative quantitative data on the change of λ depending on the fiber direction : in the tangential direction, this coefficient is 0.90-0.95 of its value in the radial direction; in the longitudinal direction is 1.75-2.25 times greater than in the transverse direction. The literature data on the heat transfer coefficient λ of dry wood (pine) at a temperature of 20 ° C were studied.

Coefficient of thermal conductivity of a pine tree in directions (Bt/(m, ^{0}C)		
Longitudinal	Radial	Tangential
-	0.15	-
0.31	0.16	0.14
-	-	0.12
0.38	-	0.12
0.25	-	0.09
0.18	-	0.09
0.34	-	0.15

Results shows that of wood heat conductivity to the temperature proportionate increased goes.

With an increase in humidity (ph, %) the coefficient of thermal conductivity of wood increases W/(m, °C) and can be calculated using the equations

$$l = (2+0.0406\,\varphi)\ \ \gamma * 10^{-4} + 0.0238\ (\varphi \text{at} < 40\%);$$

$$l = (2+0.0544\,\varphi)\ \ \gamma * 10^{-4} + 0.0238\ (\varphi \text{at} > 40\%).$$

For wet wood, the increase in thermal conductivity with increasing temperature occurs more than for dry wood. A nomogram was compiled to determine the thermal conductivity coefficient 2 of wood (pine) at variable humidity at temperatures up to 100 ° C. When using correction factors, this nomogram can be used to determine factor 2 of other types of wood.

Experimental determination of the properties of heat transfer along the fibers of wood (pine and larch) was carried out using the pulse method of a constant power linear heat source.

The choice of the method was determined by the possibility of obtaining all the heat transfer properties necessary for solving thermophysical problems of wood drying, impregnation and fire resistance of wooden structures from one experiment. The general diagram of the installation for determining the heat transfer properties of wood using the heat shock method is shown in Fig.

The test specimen consists of three wooden plates with dimensions of 100x100x40mm and 100x100x7mm. The average density of wood samples: pine -359 kg / m^3 and larch -694 kg / m^3. The moisture content of the samples during the test was 3%.

14 composite samples from each wood type were tested. The values of heat capacity and thermal conductivity coefficients of the obtained wood were determined.

A review of literature data on the thermal conductivity of wood and test results, the specific heat capacity C values of the data available in the literature and the thermal conductivity of qa ragai wood allows us to conclude that the data on the coefficient of permeability varies sufficiently . In this regard, it is desirable to comprehensively study the thermophysical properties of wood, taking into account the influence of temperature and humidity factors. It is recommended to use them when drying, impregnating wood and calculating the fire resistance of wooden structures.

Wood	Density kg/m^3	Internal capacity C, kDj/(kg, ^{0}C)	Thermal conductivity coefficient, Bt/(m, ^{0}C)
Pine	359	1.68	0.10

lisvenninitsa	694	1.35	0.12

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