HEAT TECHNICAL PROPERTIES OF EXTERNAL WALLS' PANELS WITH USING HARMINSULATION ON THE BASIS OF THE PLANT-ASTRINGENT COMPOZITION

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The research of thermal technical properties of panels was conducted in climatic camera in the conditions of stationary heat transfer. This research was conducted with aim to evaluate the thermal resistance of whole panels and theirs constructive layers, the distribution of temperature in the walls' thickness and on theirs surfaces.

4 experimental panels of external walls with using of guza-poya (cotton stems) were as researched objects. In running of researches of thermally technical properties of external wall panels of different constructions the panels' thickness was accepted equal to 250 *mm*.

The wall panels П-1, П-2 and П-3 were produced with warmer on the gypsum-ground-guza-poya thermoinsulating material (GGGTM) [1], and the panel П-4 is one layer arborlithe on the base of guza-poya.

For three-layer panel П-1 the thickness of inner reinforced bearing layer made on concrete B 10 has consisted 100 *mm* that is minimal recommended thickness for large panel walls according to СНиП II-7-81 "Construction in the seismic regions" ("Construction Norms and Rules", USSR). The external reinforced concrete layer is 50 *mm*. GGGTM had been used as warmer for this panel with thickness of following materials' consumption per 1 m^3 of the mixture, please, see the Table.

Table

Composition of gypsum-ground-guza-poya heat-insulating material (GGGHM) and arbolithe that are used in the tested panels

Code Of the Pa-n els	Characters of the materials in dry conditions		Consumption of the materials per 1 m^3 of mixture					
	Ave-r age Den-si ty γ_0, kg/m^3	Coeffi-cient of heat transfer, λ_0, $Wt/(m\ ^0C)$	Const-ruc-tion Gyp-sum, *kg*	Loess soil, *kg*	Ce-ment, *kg*	Crushed guza-poya of fraction till 30 *mm, kg*	Wa-ter, *1.*	10% *CaCl* Solu-tion, *l.*
П-1	650	0.248	104	346	-	90	132	10
П-2	600	0.212	159	226	-	100	212	10
П-3	500	0.153	145	161	-	116	153	10
П-4	641	0.110	.	.	380	225	478	2.44 *kg* (100% *CaCl*)

The advantage of GGGTM using in comparison with the using of traditional mineral wool as warmer for three-layer panels consists in its high technological properties, that is the GGGTM may be laid as "monolith" during the production of the panels П-l and П-2.

The construction of П-2 panel is the same a П-1 one, but composition of warmer on the plastic foam of ПСБ-С brand with thickness 150 - 200 *mm* was laid in clearances between butt ends of the panels and the cassette's frame for decreasing of heat losses. The splits were caulked by mineral wool. The П-2 and П-3 panels were heat-insulated from each other in the same way, and also it was done for П-3 and П-4 ones.

The temperature measurements were distantly done on surfaces of the panels, on the borders of constructive panels' layers and for air in the cold and warm compartments by copper-constantan thermocouples and electronic voltmeter of B 7-21 type.

The thermocouples were fixed on panels' surfaces by gypsum after mounting the constructions in the camera. The parameters of air environment in the camera were registered all the day and night round by thermograph. They also were periodically checked by aspiration phsychrometer of Assman. The heat measuring devices were attached to panels' surfaces for measurements of density of heat flow, which were connected to the selfrecording potentiometer КСП-4.

The values of heat resistances of the panels were determined in accordance with ГОСТ 26254 (State Standard) - "Methods of determination of resistance of wall constructions to heat transfer" [3].

The value of actual significance of heat flow's density has been determined by formula:

$$q_f = q(\tau_i - \tau_c)/(q(\tau_{hi} - \tau_c) - q(R_t + R_g)) \qquad (1)$$

where q - the average value of heat flow during calculated period, Wt/m^2; τ_i, τ_e, $\tau_{h.i}$ - the average values of temperatures accordingly to inner and external surfaces of the panels, and also for heat measuring device's head is directed in the camera, *°C;* R_t, and R_q - are the thermoresistances of heat measuring devices and layer of fixing material - the gypsum. It has the thickness of 1.5 *mm* at its calculated humidity. In this case we can use the value:

$$R_2 = 0.0015/0/042 = 0.003(m^{2\,o}C)/Wt$$

The surface of П-l panel was divided in 8 zone and the П-2, П-3 and П-4 panels were divided in 3 parts for determination of reduced thermoresistance of heat transfer (Fig. 2). The average temperatures of surfaces τ_{ij} and τ_{ei} and the resistances for heat transfer were GGGHM is a little different. It can be seen on the consumption of the materials from the Table.

Two-layer panel П-3 consists of the bearing reinforced layer (the concrete of B 10 class) with thickness 100 *mm* and warming layer on base of cement-sand mixture B 7.5 class with thickness 30 *mm*. The consumption of warming components per 1 m^3 of mixture corresponds to the composition given in the Table.

It should be noted that the limit of strength of GGGTM of different densities at compression according to laboratory tests is equal to 0.18 - 0.80 MPa.

One layer arborlithe panel П-4 consists of an layer of arborlithe with the thickness 210 *nun* on base of guza-poya, and it's plastered on both sides by cement-sand mixture of B7.5 class with thickness 20 *nun*. The selection of arborlithe composition was made according to [2], and its data of materials' consumption per 1 m^3 of arborlithe mixture and theirs characters are given in the table 1.

The thermally-technical researches have been made in the climatic camera №1 of the "Laboratory of heat and air conditions" of ЦНИИЭП жилища ("Central Scientific Research Institute of Experimental Design of Houses", Moscow) for proposed four fragments of wall panels (П-1, П-2, П-3 and П-4) with formation of the joint of bearing reinforced partition with the panels П-1 and П-2. The bearing reinforced partition is the inner wall panel П-5 with thickness 160 *mm* on concrete of B7.5 class.

Climatic refrigerating camera has two compartments: warm and cold ones. The conditions of natural climate are supported in the warm compartment of the camera. The sizes of the warm compartment are in plan equal to 1.6x7.8 *m* and the height has 3.5 m. There is an opening with sizes 6.5x2.8 *m* between the warm and cold compartments of the climatic camera, where the tested constructions are mounted forming the corresponding conjunctions between panels of external walls and partitions.

The tested panels were mounted on an immovable cassette in the zone of crane and they were put in the climatic camera, after that the fragment of inner wall П-5 with sizes 2650x600x160 *mm* was attached to panels П-l and П-2 and then the joint was walled up. The following problems were decided in the conditions of stationary heat transfer such as:

- the determination of the temperature distribution along the sections of panels' fragments;
- the more accurate deflation of the value of thermal resistances of the constructions at whole and of each layer in particular.

Herewith the parameters of inner air те supported accordingly to the design norms for dwelling houses (humidity $\varphi_i = 55\%$, temperature t_i = (18±2)°*C* and the temperature of the cold compartment was t_e = -20°*C*.

Calculated for inner of each zone, and after that the reduced resistance was calculated by formula:

$$R_0^{red} = F / \sum (F_j / R_{oj})$$

where, *F* and F_j, - are accordingly the squares of the panels and each zone, m^2.

The resistance to heat transfer was calculated as:

$$R_{0j} = R_{ij} + R_{cj} + R_{ej} = (t_{ij} - \tau_{ij}) / q_{\varphi j} - (t_{ij} - \tau_{ej}) / q_{\varphi j} - (\tau_{ej} - t_{ej}) / q_{\varphi j} \quad (3)$$

The humidity of the constructions and theirs layers were was checked in running of the researches. In this case the samples of the materials were taken from both sides of constructions and they were dried till the constant weight at temperature 60°C. The results of the measurements show that the absolute value of humidity of GGGTM was equal to 6% in the panel П-1 and it was 5.9% in the panel П-3. СНиП requires at the same time the humidity of 2% at A [4] exploitating conditions. The humidity of arborlithe panel П-4 was 11.4% in comparison to normalized 10% one. The high humidity of warming materials in the panels is explained by incomplete drying up of the panels in the period between theirs production and installing of them in the testing camera.

The results of determination of the average values of reduced heat resistances of all the panels' surfaces for panels П-1, П-2, П-3 and П-4 are accordingly R_o = 0.525, 0.616, 0.748 and 0.996 *(m²·°C)/Wt* The comparison of these data with required value of heat resistance *R* = 0.651 *(m²·°C)/Wt* for Kurgon-teppa, that is the most cold cotton-planting area of Tajikistan, show that from researched objects the panels П-3 and П-4 meet the requirements of СНиП II-3-79** [4]. The insufficient thermal resistance of panels П-1 and П-2 indicate on necessity of using of components with more low heat transfer or on necessity of the increasing of thickness of the warmer's layer. Selection of GGGTM with more low heat transfer may be done due to following formula:

$$\lambda_0 = 0{,}080 - 0{,}127 Z_1 - 0{,}463 Z_2 + 0{,}958 Z_3 + 0{,}009 Z_1^2 + 0{,}800 Z_3^2 + 0{,}125 Z_1 \cdot Z_2 + 0{,}075 Z_1 \cdot Z_3 \quad (4)$$

According to formula (4) the following values were accepted:

$$Z_1 = G_{gp} / G_{gr}; \quad Z_2 = G_{cr.gp} / (G_{gp} + G_{gr});$$
$$Z_3 = B / (G_{gp} + G_{gr}).$$

where G_{qp}, G_{qr} and $G_{cr.qp}$ - are accordingly the weights of gypsum, ground and crushed guza-poya per 1 m^3 of mixture, *kg*; *B* - is the quantity of water per 1 m^3 of mixture, *1*.

λ_w, for GGGHM is determined from dependence on the average density in the dry conditions γ_o, *(kg/m³)* and balanced humidity *w*, % by the formula:

$$\lambda_w = \lambda_0 + (0{,}00097 + 0{,}00001\gamma_0)w$$

Giving formula is fit in limits (350 + 50) < γ_o < (650 ± 50) *kg/m³* and *w* < 15 %.

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