International Journal of Culture and Modernity
ISSN 2697-2131, **Volume 9**
https://ijcm.academicjournal.io/index.php/ijcm

Ways to use energy-efficient wall structures in residential buildings.

Mamadaliev Kh.E., Sirozhiddinov Sh.N.
(Samarkand State Architectural and Construction Institute)

Annotation: Today, in order to improve the energy efficiency of buildings around the world, they are used as external barrier structures with various thermal protection of external walls and roofs. In addition, in the design and construction, external wall structures of various compositions are used - layers of district thermal insulation. In Russia, for example, the construction of buildings with fixed formwork (Fixed formwork) is widespread, the outer walls of which are called "warm house".

Keywords: polystyrene, thermophysical experiments, barrier structures, cement-sand plaster.

At present, JV LLC "SAM ROS KHOLOD" in the Samarkand region also produces fixed formwork from expanded polystyrene.

The advantages of this design are as follows:

1. Allows you to build a variety of energy efficient buildings;
2. Significantly reduces construction time;
3. Increases thermal protection of the outer wall of the building;
4. Along with the advantages of the above design, the main disadvantages are:
5. For the conditions of Uzbekistan, this construction is theoretically not based on thermophysics;
6. The non-removable monolithic structure made of expanded polystyrene is practically not based on thermophysical experiments.

The fixed form of expanded polystyrene was made at JV LLC "SAM ROS KHOLOD" in the laboratory of the department "Construction, design and maintenance of structures" of the Samarkand State Architectural and Construction Institute.

The experiment was carried out in accordance with the requirements of the methodology UzDSt-809-97 "Determination of the resistance to heat transfer of enclosing structures". [5]

To compare the experimental results with theoretical studies, we first determine the resistance of this structure to heat transfer. To do this, we present in the calculations a diagram of the wall structure in (Figure 1).

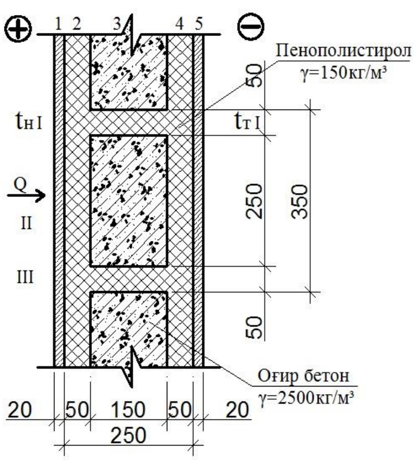

Figure 1. Scheme of the permanent formwork of a wall structure made of expanded polystyrene.

Let us determine the resistance to heat transfer of the non-removable molded structure of the external wall made of expanded polystyrene, shown in the figure.

For thermophysical calculations, we will accept the following initial data:

1. Cement-sand plaster $\gamma = 1800 kg/m^3$, thermal conductivity coefficient $\lambda = 0.76 Vt/\mathrm{m}\ {}^\circ c$.

2. Cast form from expanded polystyrene, density $\gamma_0 = 150 kg/m^3$, thermal conductivity coefficient

International Journal of Culture and Modernity
ISSN 2697-2131, **Volume 9**
https://ijcm.academicjournal.io/index.php/ijcm

$\lambda = 0.052 Vt / \text{m} \ ^{\circ}c$.

3. Heavy concrete, density $\gamma_0 = 2500 kg / m^3$, thermal conductivity coefficient $\lambda = 1.92 Vt / \text{m} \ ^{\circ}c$.

4. Facade cement-sand plaster $\gamma = 1800 kg / m^3$, thermal conductivity coefficient $\lambda = 0.76 Vt / m \ ^{\circ}c$.

This structure consists of a non-uniform building material parallel and perpendicular to the direction of the heat flow.

We cut the structure with a plane parallel to the direction of the heat flow and divide it into parts I, II, III. The first and third parts are made of expanded polystyrene, the inner and outer surfaces of which are plastered. We determine the heat transfer resistance for these parts using the following formula.

$$R_I = R_{III} = \frac{0.250}{0.052} + \frac{0.02}{0.76} \times 2 = 4.807 + 0.052 = 4.859 m^2 \cdot {}^{\circ}C / Vt$$

Surface of Parts I and II $F_I = F_{III} = 0.05 m^2$.

The second part of the structure consists of expanded polystyrene and heavy concrete, plastered on both sides.

$$R_{II} = \frac{0.02}{0.76} + \frac{0.05}{0.052} + \frac{0.15}{1.92} + \frac{0.05}{0.052} + \frac{0.02}{0.76} = 0.026 + 0.961 + 0.078 +$$

$$+ 0.961 + 0.026 = 2.52 m^2 \cdot {}^{\circ}C / Vt$$

The surface of the second part is $F_{II} = 0.25 m^2$.

We determine the heat transfer resistance of this structure using the following formula.

$$R_{II} = \frac{F_I + F_{II} + F_{III} + F_{IV} + F_V}{\frac{F_I}{R_I} + \frac{F_{II}}{R_{II}} + \frac{F_{III}}{R_{III}} + \frac{F_{IV}}{R_{IV}} + \frac{F_V}{R_V}};$$

Here, $R_I, R_{II}, R...$ – is the resistance to heat transfer of individual layers, $m^2 \cdot {}^{\circ}C / Vt$;

$F_I, F_{II}, F...$ – are the surfaces of individual parts, m^2;

$$R_{II} = \frac{0.05 + 0.05 + 0.25 + 0.05 + 0.05}{\frac{0.05}{4.859} + \frac{0.05}{4.859} + \frac{0.25}{2.052} + \frac{0.05}{4.859} + \frac{0.05}{4.859}} = \frac{0.45}{0.164} = 2.74 m^2 \cdot {}^{\circ}C / Vt$$

Cut it out with a plane perpendicular to the direction of the heat flow of the structure, and divide it into 1, 2, 3, 4 and 5 layers. (Figure 1).

1st and 5th layers, internal and external plaster

$$R_1 = R_5 = \frac{0.02}{0.76} = 0.026 m^2 \cdot {}^{\circ}C / Vt;$$

International Journal of Culture and Modernity
ISSN 2697-2131, **Volume 9**
https://ijcm.academicjournal.io/index.php/ijcm

2nd and 4th layers, expanded polystyrene

$$R_2 = R_4 = \frac{0.05}{0.052} = 0.961 m^2 \cdot {}^\circ C / Vt;$$

Since layer 3 of heavy concrete is heterogeneous, the thermal conductivity of the structure is determined by the following formula.

$$\lambda_{\text{The average}} = \frac{\lambda_I \times F_I + \lambda_{II} \times F_{II} + \lambda_{III} \times F_{III} + \lambda_{IV} \times F_{IV} + \lambda_V \times F_V}{F_I + F_{II} + F_{III} + F_{IV} + F_V};$$

Here, $\lambda_I, \lambda_{II} \ldots$ is the coefficient of thermal conductivity of the materials that make up the individual layers, $Vt / m^\circ c$;

$F_I, F_{II} \ldots$ Surfaces of individual layers, m^2;

$$\lambda_{\text{The average}} = \frac{0{,}76 \times 0{,}35 + 0{,}05 \times 0{,}052 + 0{,}25 \times 1{,}92 + 0{,}05 \times 0{,}052 + 0{,}76 \times 0{,}35}{0{,}35 + 0{,}05 + 0{,}25 + 0{,}05 + 0{,}35} =$$

$$= \frac{1{,}014}{1{,}05} = 0{,}965 Vt / \text{m} \ {}^\circ c;$$

Heat transfer resistance of the third layer $R_3 = \frac{0.15}{0.965} = 0.155 m^2 \cdot {}^\circ C / Vt;$

Means:

$$R_\perp = R_1 + R_2 + R_3 + R_4 + R_5 = 0{,}026 + 0{,}961 + 0{,}155 + 0{,}961 + 0{,}26 = 2{,}129 m^2 \cdot {}^\circ C / Vt;$$

The results of many applied research and thermophysical calculations have shown that the value of the resistance to heat transfer (R_{II})is always greater than the true value, and the value $R_\perp$ is less than the true one. [1]

Therefore, since the structure is not uniform, the thermal conductivity resistance is determined by the following formula.

$$R = \frac{R_{II} + 2R_\perp}{3} = \frac{2.74 + 2 \times 2.129}{3} = 2.332 m^2 \cdot {}^\circ C / Vt;$$

The difference between the heat transfer resistance of R_{II} and $R_\perp$ is 23.3%.

Determine the total resistance to heat transfer of the fixed formwork of the wall structure made of polystyrene.

$$R_{\text{General}} = R_u + R + R_T = 0{,}115 + 2{,}332 + 0{,}043 = 2{,}490 m^2 \cdot {}^\circ C / Vt;$$

Let us compare the calculation result with the heat transfer resistance given for the 1st, 2nd and 3rd levels of thermal protection, given in the requirements of BR 2.01.04-97 *. At the same time, for the 1st level of thermal protection $R_0^{TP} = 0{,}94 m^2 \cdot {}^\circ C / Vt;$ for the outer walls of residential buildings, for the 2nd level $R_0^{TP} = 1{,}8 m^2 \cdot {}^\circ C / Vt;$ and for the 3rd level of thermal protection $R_0^{TP} = 2{,}6 m^2 \cdot {}^\circ C / Vt;$.

International Journal of Culture and Modernity
ISSN 2697-2131, **Volume 9**
https://ijcm.academicjournal.io/index.php/ijcm

Based on the results of theoretical studies, it can be concluded that the general thermal protection of the fixed formwork of the wall structure made of expanded polystyrene, which we recommend, meets the requirements of BR 2.01.04-97 *. However, in the requirements of clause 2.1 BR 2.01.04-97 *, it is necessary to determine whether condensate moisture forms in non-uniform layers of a multi-layer structure. Therefore, we determine whether condensate moisture is formed in this structure by the following graphic-analytical method:

1) Determine the temperature in the non-uniform layers of the permanent formwork of the polystyrene wall structure.

2) Using the temperature curve, we determine the line of maximum elasticity of water vapor in the layers of the wall structure. Then, in this design, a true line of water vapor pressure is drawn. If the line of maximum elasticity of water vapor (E) and the line of true elasticity (e) do not intersect, condensation will not form in the barrier structure, otherwise condensation is likely to form. Therefore, we determine the temperature in the layers of the wall structure shown in Figure 1 using the following formula.

$$\tau_I = t_I - \frac{t_I + t_T}{R_y} R_I;$$

Here, τ_i - is the temperature of the inner surface of the outer wall, ${}^0C$; t_i - is the temperature of the inner air, ${}^0C$; t_T - is the average monthly temperature of the outside air in the coldest period, and ${}^0C$; R_y - is the total resistance to heat transfer of the air of the outer wall $m^2 \cdot {}^\circ C / Vt$;

R_I - ташқи девор ички сиртини иссиқлик узатиш қаршилиги $m^2 \cdot {}^\circ C / Vt$;

$$\tau_I = 18 - \frac{18 - 0.5}{2.490} * 0.114 = +17{,}19.{}^\circ C; E_1 = 14{,}7 mm.cm.\text{outward.}$$

$$\tau_1 = 18 - \frac{18 - 0.5}{2.490}(0.114 + 0.026) = 18 - 7.125 * 0.14 = 17^\circ C;$$

$$E_2 = 14{,}53 \ mm.cm.\text{outward.}$$

$$\tau_2 = 18 - 7{,}125(0.114 + 0.026 + 0{,}961) = 18 - 7.125 * 1{,}101 = 10{,}25^\circ$$

$$E_3 = 9{,}3 mm.cm.\text{outward.}$$

$$\tau_3 = 18 - 7{,}125(1{,}101 + 0.052) = 18 - 7.125 * 1{,}153 = 9{,}88^\circ C;$$

$$E_4 = 91{,}3 mm.cm.\text{outward.}$$

$$\tau_4 = 18 - 7{,}125(0.1{,}153 + 0.961) = 18 - 7.125 * 2{,}114 = 3{,}14^\circ C;$$

$$E_5 = 5{,}7 mm.cm.\text{outward.}$$

International Journal of Culture and Modernity
ISSN 2697-2131, **Volume 9**
https://ijcm.academicjournal.io/index.php/ijcm

$$\tau_T = 18 - 7{,}125(2{,}114 + 0.026) = 18 - 7.125 * 2{,}140 = 2{,}95^{\circ}C;$$
$$E_T = 5{,}67 mm.cm.\text{outward}.$$

Based on the values determined above, we draw a temperature line in Figure 2. Based on the temperature line in this figure, we draw a line of maximum water vapor pressure, determining the maximum water vapor pressure [1]. Let us determine the true elasticity (e) of water vapor on the inner and outer surfaces of the wall in the following order.

$$e_N = \frac{\varphi_N * E_N}{100} = \frac{55*14{,}67}{100} = 8{,}06 \ mm.cm.\text{outward}.$$
$$e_T = \frac{65*5{,}59}{100} = 3{,}63 \ mm.cm.\text{outward}.$$

We lower all the detected indicators to Figure 2.

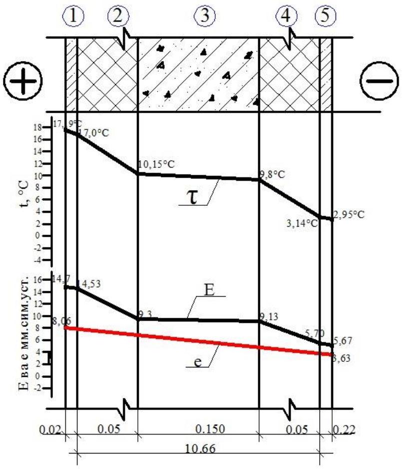

Figure 2 Moisture content of the permanent formwork of a wall structure made of expanded polystyrene:

1- cement-sand plaster;
2- expanded polystyrene;
3- heavy concrete;
4- expanded polystyrene;
5- cement-sand plaster;

As can be seen from the figure, the maximum elasticity E of water vapor and the true elasticity e of water vapor do not intersect along the lines e, which means that condensate moisture does not form in this structure;

From the above theoretical studies, the following conclusions can be drawn:

1) From the above theoretical studies, the following conclusions can be drawn:

2) The calculation results showed that the thermal protection of the fixed formwork of the wall structure made of expanded polystyrene is sufficient for the conditions of Uzbekistan and meets the requirements of BR 2.01.04-97 *.

List of used literature:

1. Shukurov G.Sh., Boboev S.M. Architectural physics. Part 1. Building thermal physics. - T.: Mekhnat, 2005. Textbook.
2. Shukurov G.Sh., Islomova D.G. Building physics. Samarkand. 2013.
3. BR -2.01.04-97 *. Construction heat engineering. T., 2011
4. BR -2.01.01-94. Climatic and physical-geological data for design. T., 1996.
5. UzDSt 809-97 "Determination of resistance to heat transfer of enclosing structures" T., 1997.