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Increasing the Energy Efficiency of Buildings During the Renovation Process

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Annotation: The results of the theoretical-thermophysical research and the humidity regime of the external wall for increasing the energy efficiency of the building in V state.

Key words: Renovation, thermal protection, heat transfer coefficient, heat transfer resistance.

Introduction

It is known that most of the residential, medical, children's institutions, schools, lyceums, colleges and boarding houses that are currently being built and used are in a state of repair and overhaul. Based on the requirements of QMQ 2.01.04-97*, it is necessary to increase thermal protection in order to increase their energy efficiency during the construction, repair and overhaul of the above-mentioned buildings [1]. For this, the total heat transfer resistance of the external walls and roof coverings of the building is determined. After that, the heat transfer resistance of these structures is determined based on the requirements of QMQ 2.01.04-97* depending on the heating period of the construction site. From the conducted theoretical studies, it became known that the heat transfer resistance for the external wall of residential buildings, which is given according to the requirement of the 1st level of thermal protection, is for Samarkand. This indicator is equal to for the 2nd level of heat protection and for the 3rd level of heat protection.$R_o^{tr} = 0{,}94 \text{ м}^2 \cdot °C/Vт R_o^{tr} = 1{,}8 \text{ м}^2 \cdot °C/Vt R_o^{tr} = 2{,}6 \text{ м}^2 \cdot °C/Vt$

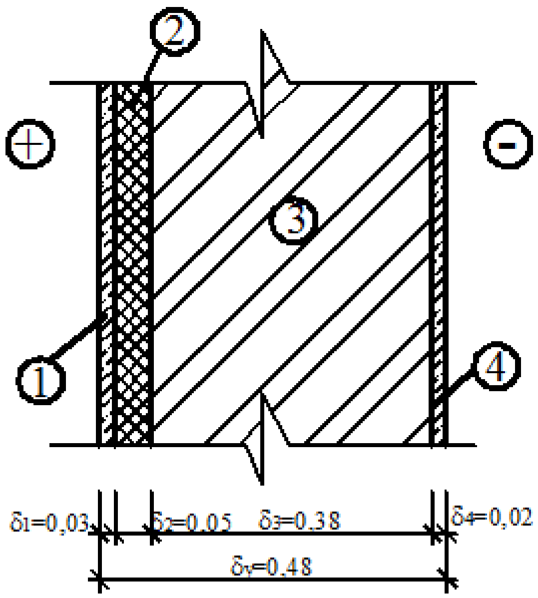
The actual total heat transfer resistance of these buildings is Ro if the thickness of the brick wall is 0.38 m. If we compare the heat transfer resistance given above with the actual heat transfer resistance, we get the following. The average heat transfer resistance of buildings used for the 1st level of thermal protection is 31$= 0{,}60 - 0{,}70 \text{ м}^2 \cdot °C/Vt\%$.

The average heat transfer resistance of the buildings used for the 2nd level of heat protection is 64. For the 3rd level of heat protection, the actual heat transfer resistance of a brick wall with a thickness of 1.5 is given in QMQ 2.01.04-97* it is 4 times smaller than the transmission resistance. So, during the repair process, it is not necessary to increase the thickness of the outer wall by 4 times, that is, 1.5-2m. To increase the thermal protection of the outer wall, it is effective to use heat-insulating mineral building materials with a small heat transfer coefficient. Such building materials include the following:%

Polystyrene with a density of 15 to 150 kg/m3 (TU6-0.5-11-78-78); Styrofoam with a density of 50 to 125 kg/m3 (PXV TU6-0.5-11-78-75); Hard and super hard mineral plates with a density of 50 to 300 kg/m3, etc.

At present, the problem of which side of the structure to build the heat-insulating layer to increase the thermal protection of the outer wall and roof covering is being solved differently in different places. It is necessary to determine the temperature field in the structure with increased heat protection in order to give correct recommendations based on the thermal-physical theory of this issue. Then we determine the maximum elasticity of water vapor in the layers of the outer wall. Based on these determined quantities, we determine the actual elasticity of water vapor and draw the actual and maximum elasticity lines of temperature and water vapor at the thickness of the outer wall according to these parameters. If the maximum elasticity line of water vapor Ye and the actual elasticity line Ye do not intersect with each other, condensation moisture will not form in the barrier structure.

So, to increase the thermal protection of the outer wall, we draw the scheme of the outer wall on an arbitrary scale. Draw a temperature line on this wall scheme and draw the maximum elasticity line of water vapor on this scheme based on this temperature line. In addition, the indoor air temperature and relative humidity are selected based on the suitability of the building. For example, for residential buildings, the relative humidity of the indoor air is 50-60. We accept internal temperature ti. For external air temperature and relative humidity, the average temperature and humidity of the coldest five days and the month of January are taken from QMQ 2.01.01-94 based on the construction region. We determine the probability of the appearance of condensate moisture in the outer wall layers for the case of constant water vapor flow in the following order.



For this, during the repair process, we draw a temperature line on the brick wall layers, which have increased heat protection with 5 cm foam polystyrene. The calculation scheme of this wall is shown in Figure 1 below.% $= 18°C$

Figure 1. Calculation scheme of a brick wall with increased thermal protection.

1st layer of cement-sand plaster, thickness, density, thermal conductivity coefficient

$$\delta_1 = 30мм \gamma_0 = 1600кг/м^3 \lambda_1 = 0,7\ Vt/(м \cdot °C)$$

2nd layer penoplast, thickness, density, thermal conductivity coefficient; 3rd layer brick wall, thickness, density, heat transfer coefficient; 4th layer,

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cement-sand plaster thickness, density, thermal conductivity coefficient $\delta_2 = 50мм\gamma_0 = 125кг/м^3 \lambda_2 = 0{,}06\ Vt/(м\cdot°C) \delta_3 = 380мм\gamma_0 = 1800kg/м^3 \lambda_3 = 0{,}7\ Вт/(м\cdot°C) \delta_4 = 20мм\gamma_0 = 1800kg/м^3 \lambda_4 = 0{,}76\ Vt/(м\cdot°C)$

Internal and external temperature difference$t_и - t_т = 32°C$.

The total heat transfer resistance is determined using the following formula.

$$R_o = R_B + R_1 + R_2 + R_3 + R_4 + R_H = \frac{1}{\alpha_B} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{\delta_4}{\lambda_4} + \frac{1}{\alpha_H} = 1{,}603\ м^2\cdot°C/Vt$$

We determine the temperature in the outer wall layers using the following formula [1].

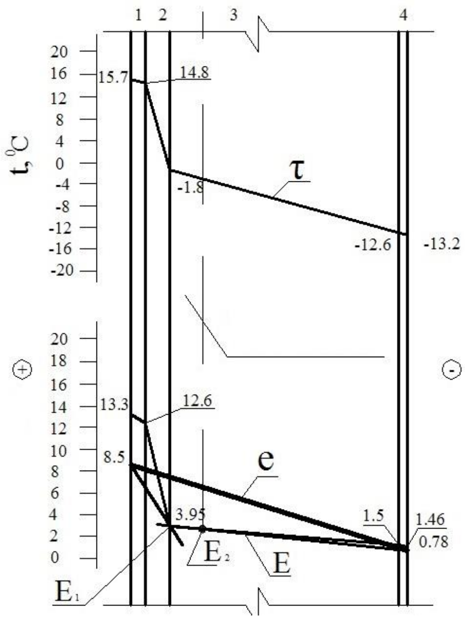
$$\tau_и = t_и - \frac{t_и - t_m}{R_y}\cdot R_и = 18. - \frac{32}{1{,}603}(0{,}115) = 15{,}7°C$$

$\tau_1 = 14{,}8°C$; ; ; .$\tau_2 = -1{,}8°C$ $\tau_3 = -12{,}6°C$$\tau_т = -13{,}2°C$

We determine the maximum water vapor elasticity according to the temperature in the layers of the structure from [1].

$E_и = 13{,}38мм.sm/ust$;

$E_1 = 12{,}62мм.sm/ust$; $E_2 = 3{,}95мм.sm/ust$; $E_3 = 1{,}55мм.sm/ust$; $E_т = 1{,}46мм.sm/ust$;



Based on these indicators, we determine the true elasticity of water vapor using the following formula:$\varphi = \frac{e}{E}\cdot 100\%$;

$$e_и = \frac{\varphi\cdot E}{100\%} = 8{,}51мм.sm/ust$$

$e_т = \frac{\varphi\cdot E}{100\%} = 0.78\ мм.sm/ust$Based on the values given above, we draw the temperature line in Figure 2, and based on the temperature line in this figure, we draw the lines of maximum and true elasticity of water vapor.

Figure 2. Thermal protection of the brick wall from the inner surface with expanded polystyrene, moisture condition of the construction.

It was known from the graph drawn in the results of the calculation of the moisture condition in the steady state of the structure, the thermal protection of the brick wall is increased from the inner surface of the polystyrene material, that is, condensate is formed in the thickness of the wall. Therefore, such a situation does not meet the requirement, because moisture increases in the thickness of the wall and affects its thermal and physical properties during use. Such constructions do not meet sanitary and hygienic requirements. Therefore, we install a thermal insulation layer on the outer surface of the outer wall to increase the thermal protection of the outer wall. The computational scheme of this wall is presented in Figure 3.

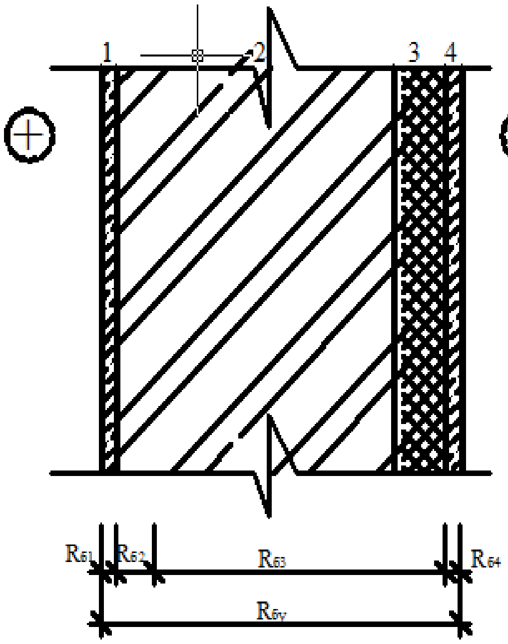


Figure 3. Calculation scheme of the structure built from the outer surface of the brick wall with a thermal insulation layer.

Initial data is taken from the above accounts. The internal air temperature of the room ti, the relative humidity of the internal air, the maximum elasticity of water vapor Ye The actual elasticity of water vapor is determined from the formula.$= 18°C\varphi = 55\% . = 15{,}48\text{мм}. sm/ust.$

$$e_и = \frac{\varphi \cdot E}{100\%} = 8{,}51\text{мм}.\ sm/ust.$$

Average relative humidity in Samarkand in January$\varphi = 58\%$

The maximum elasticity of water vapor for outdoor air is Ye$= 4{,}79\text{мм}.\ sm/ust$

The true elasticity of the outside air is determined using the following formula.$e_т = \frac{\varphi \cdot E}{100\%} = 2{,}77\ \text{мм}.\ sm/ust.$

In order to draw the calculation scheme of this wall with increased heat protection, first of all, it is necessary to determine the water vapor absorption resistance, because if the total thickness of the wall is equal to the water vapor absorption resistance in the scheme, if its diagram is drawn, the formation of condensate on the wall or It is possible to get a clear answer. We take the water vapor absorption resistance of each layer material, whose calculation form is given above, from QMQ 2.01.04-97*.

1) Cement-sand plaster. thickness density water vapor absorption coefficient; $\delta_1 = 0{,}03\text{м}, \gamma_o = 1800kg/\text{м}^3\ \mu_1 = 0{,}09mg/(\text{м} \cdot \text{с} \cdot Pa)$

2) Brick wall thickness density, $\delta_2 = 0{,}38\text{м}, \gamma_o = 1800kg/\text{м}^3$

water vapor absorption coefficient;$\mu_2 = 0{,}11\text{мг}/(\text{м} \cdot \text{с} \cdot Pa)$

3) For the thermal insulation layer, we take foam polystyrene with density, its water vapor absorption coefficient ;$\gamma_o = 35 - 45 кг/м^3 \mu_3 = 0{,}005 мг/(м \cdot c \cdot Pa)$

4) Cement-sand plaster thickness density water vapor absorption coefficient. $\delta_4 = 0{,}03м, \gamma_o = 1800кг/м^3$, $\mu_4 = 0{,}09мг/(м \cdot c \cdot Pa)$

We determine the water vapor absorption resistance for each layer using the following formula.

$$R_{б1} = \frac{\delta_1}{\mu_1} = \frac{0{,}03}{0{,}09} = 0{,}33(м^2 \cdot c \cdot Pa)/mg; R_{б2} = 3{,}45(м^2 \cdot c \cdot Pa)/mg;$$

$$R_{б3} = 10(м^2 \cdot c \cdot Pa)/mg; ;R_{б4} = 0{,}33(м^2 \cdot c \cdot Pa)/mg$$

The overall vapor absorption coefficient of the wall,

$$R_{бу} = R_{б1} + R_{б2} + R_{б3} + R_{б4} = 14{,}11(м^2 \cdot c \cdot Pa)/mg;$$

$General\ of\ the\ wall$ heat transfer resistance is determined using the following formula.

$$R_o = R_B + R_1 + R_2 + R_3 + R_4 + R_H = \frac{1}{\alpha_B} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{\delta_4}{\lambda_4} + \frac{1}{\alpha_H} = 2{,}389\ м^2 \cdot °C/Vt$$

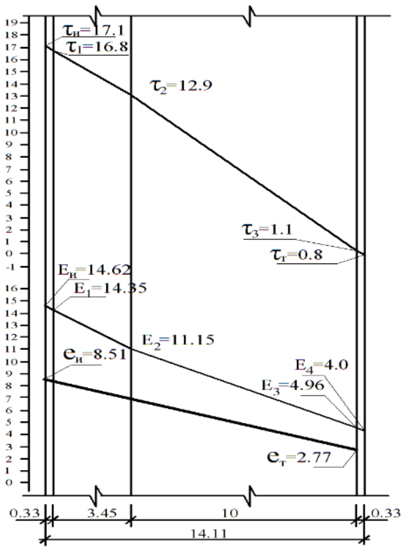
This wallWe determine the temperature in the layers of the calculation form using the following formula.

$$\tau_и = t_и - \frac{t_и - t_m}{R_у} \cdot R_и = 18. - \frac{18-0.5}{2{,}389}(0{,}115) = 17.1°C$$

$$\tau_1 = t_и - \frac{t_и - t_m}{R_у} \cdot (R_и + R_1) = 16.8.°C$$

$$\tau_2 = 12.9°C; ;\tau_3 = 1.1°C \tau_т = 0.8°C.$$

In accordance with the temperature of these layers, we accept the maximum elasticity of water vapor Ye from [1].



$$E_и = 14.62\ мм. mm/ust; \quad E_1 = 14.35\ мм. mm/ust;$$
$$e_и = 8{,}51мм. sm/ust; \quad e_т = 2{,}77\ мм. sm/ust.$$

Based on the values given above, we draw the temperature line in Figure 4, and based on the temperature line in this figure, we draw the lines of maximum and true elasticity of water vapor.

Figure 4.Thermal protection of the brick wall from the outer surface with expanded polystyrene, moisture condition of the structure.

As can be seen from Figure 4, Ye and Ye lines do not cross each other, so condensation moisture does not occur in this structure. The method of calculating the moisture condition of external barrier structures in the case of a constant water vapor flow is simple and straightforward, and it is possible to get clear answers to the following questions:

1) If the result of calculations shows that there will be no condensation moisture in the barrier structure, then in fact there will be no condensation moisture in this structure;

2) As a result of the calculations, it is possible to determine the increase or decrease of humidity for a year.

Therefore, as a result of our theoretical studies, if a thermal insulation layer consisting of expanded polystyrene is built on the outer surface of the structure during the repair process, the energy efficiency of the building will increase and it will meet all the requirements of thermal protection specified in QMQ 2.01.04-97*.

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