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ENERGY EFFICIENCY SOLUTION FOR A 4-FLOOR PUBLIC BUILDING CONSTRUCTED FROM PRE-CAST REINFORCED CONCRETE PANELS

Abstract: *This article shows thermal and physical calculations of external wall constructions of public buildings made of 4-floor reinforced concrete panels operated in Jizzakh city area. This solution is aimed at increasing heat resistance for summer conditions in accordance with the requirements of QMQ 2.01.04-18 "Construction thermal engineering".*

Key word: *4-floor public building, reinforced concrete panel, energy efficient, basalt facade slab, thermal inertia.*

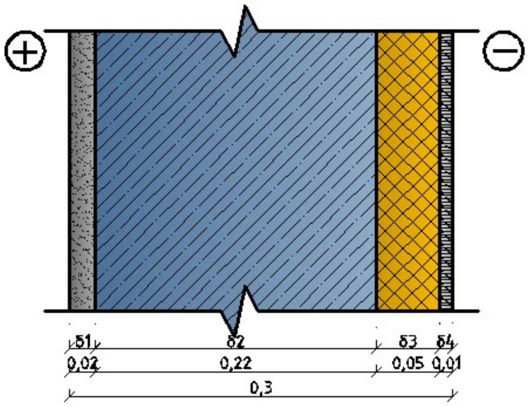
49% of all energy consumed in 1 year in the Republic of Uzbekistan is accounted for by oil equivalent buildings. This indicator leads to spending a lot of energy and money not only for the state, but also for people. Energy loss in buildings. The loss of heat energy through external barrier constructions differs depending on the number of floors in buildings, the material of the surrounding walls, the year of construction, service life, and the quality of construction works. We consider energy loss in buildings in relation to the total percentage depending on the number of floors in residential buildings: Through external walls: it is 30 – 35% in one and two – floor buildings; up to 42% in five- floor buildings; and in nine- floor buildings it is up to 49%. Through the window: in one – two – floor buildings, it is 25%; five – floor makes up 32%; 35% in nine – floor buildings;10 to 20% of heat is lost through the foundation of the building, the basement covering and the roof construction. Also, residential buildings in operation in the territory of the Republic and our regions make up 50-60% of the total buildings. Thermal protection of such buildings does not fully meet current modern requirements. This leads to excessive consumption of electricity and gas in buildings that are being operated. This is one of the urgent problems of today.

MAIN PART

Thermal-physical calculation of external wall structure of 4-floor public buildings located in Jizzakh city area. The external wall structure of the building is made of reinforced concrete panels and the external surface is covered with ceramic tiles. When calculating its total heat transfer resistance, we determine the necessary information provided for thermal-physical calculations in Building Code 2.01.01-22 and 2.01.04-18. The city of Jizzakh is located in the dry zone in terms of humidity; July: t_o=+28°C; maximum amplitude of daily fluctuations of outdoor air temperature in July: $A_¿$=23,1°C; J_{max} = 746 vt/m^2, J_{mid} = 172 vt/m^2; V=1,9m/c; $t_¿$ = 20 °C; $\varphi_¿$ = 50 %; humidity mode of the room - moderate; operating conditions of the wall – A; the thickness of the reinforced concrete panel is 220 mm, it is covered with 20 mm thick lime-sand plaster from the inside, and from the outside with ceramic tiles 5 mm thick. We determine their volumetric weight, heat transfer coefficient and heat absorption coefficient. Reinforced concrete panel: $\gamma=2500\,kg/m^3$, $\lambda=1{,}92\,Vt/(m\cdot°C)$, S=17,98 $Vt/(m^2\cdot°C)$; lime-sand plaster: $\gamma=1600\,kg/m^3$, $\lambda=0{,}7\,Vt/(m\cdot°C)$, S =8,69 $Vt/(m^2\cdot°C)$; ceramic tile: $\gamma=2000\,kg/m^3, \lambda=1{,}5\,Vt/(m\cdot°C)$, S =14$Vt/(m^2\cdot°C)$. $\Delta t_{nor}=4°C$; $\alpha_¿=8{,}7\frac{Vt}{m^2}*°C$ and $\alpha_o=23\frac{Vt}{m^2}*°C$; n=1; $\rho=0{,}45$.

Heat-physical calculation of reinforced concrete external wall construction for the summer season.

During the renovation of a 4-floor reinforced concrete panel public building in operation, it was planned to cover the exterior wall structure with 5 cm thick basalt facade tiles. We will consider the calculations of heat resistance of this wall structure.



1st figure. Calculation scheme of the wall construction made of reinforced concrete panel covered with heat insulating material. 1st layer (δ_1) lime - sand plaster, 2 nd layer (δ_2) reinforced concrete panel, 3 rd layer (δ_3) basalt facade plate, 4 rd layer (δ_4) facade gypsum tile.

Thermal inertia of structural layers is determined according to the following formula: For the first layer: $D_1=\frac{\delta_1}{\lambda_1}\cdot S_1=\frac{0,02}{0,07}\cdot 8,69=2,48,$ for the second layer: $D_2=\frac{\delta_2}{\lambda_2}\cdot S_2=\frac{0,22}{1,92}\cdot 17,98=2,06,$ for the third layer: $D_3=\frac{\delta_3}{\lambda_3}\cdot S_3=\frac{0,005}{1,5}\cdot 14=0,05,$ for the fourth layer: $D_4=\frac{\delta_4}{\lambda_4}\cdot S_4=\frac{0,05}{0,022}\cdot 0,37=0,84,$ for the fifth layer: $D_5=\frac{\delta_5}{\lambda_5}\cdot S_5=\frac{0,01}{0,41}\cdot 6,01=0,15.$

In accordance with the values of D_1, D_2, D_3, D_4, D_5, we determine the heat absorption coefficients of the outer surfaces of the layers. Since $D_1=0,37<1$, determining the value of $У_1$ using the following formula $У_1=\frac{R_1\cdot S_1^2+\alpha_{in}}{1+R_1\cdot\alpha_{in}}=\frac{0,028\cdot 8,69^2+8,7}{1+0,028\cdot 8,7}=\frac{10,81}{8,94}=1,21\,Vt/m^2\cdot{}^\circ C,$ since $D_2=2,06<1$, the heat absorption coefficient of the surface is equal to the following: $У_2=S_2=17,98$, since $D_3=0,05<1$, determining the value of $У_3$ using the following formula:

$Y_3=\frac{R_3\cdot S_3^2+Y_2}{1+R_3\cdot Y_2}=\frac{0,003\cdot 14^2+17,98}{1+0,003\cdot 17,98}=\frac{18,56}{18,03}=1,03\,Vt/m^2\cdot{}^\circ C$, since D_4=0,84<1, determining the value of Y_4 using the following formula: $Y_4=\frac{R_4\cdot S_4^2+Y_3}{1+R_4\cdot Y_3}=\frac{2,27\cdot 0,37^2+1,03}{1+2,27\cdot 1,03}=\frac{1,34}{3,36}=0,39\,Vt/m^2\cdot{}^\circ C$, since D_5=0,15<1, determining the value of Y_5 using the following formula:

$$Y_5=\frac{R_5\cdot S_5^2+Y_4}{1+R_5\cdot Y_4}=\frac{0,024\cdot 6,01^2+0,39}{1+0,024\cdot 0,39}=\frac{1,26}{0,4}=3,15\,Vt/m^2\cdot{}^\circ C$$

Determining the heat transfer coefficient of the outer surface for summer conditions: $\alpha_H=1,16\cdot(5+10\cdot\sqrt{\upsilon})=1,16(5+10\sqrt{1,9})=21,8\,Vt/m^2\cdot{}^\circ C.$ determining the attenuation of the amplitude of temperature changes when passing through the structure:

$$v=0,9e^{\frac{D}{\sqrt{2}}}\cdot\frac{(S_1+\alpha_B)\cdot(S_2+Y_1)\cdot(S_3+Y_2)\cdot(S_4+Y_3)\cdot(S_5+Y_4)\cdot(\alpha_H+Y_5)}{(S_1+Y_1)\cdot(S_2+Y_2)\cdot(S_3+Y_3)\cdot ¿\cdot(S_n+Y_n)\cdot\alpha_H}=$$
$$¿0,9\cdot 2,7182^{\frac{5,58}{\sqrt{2}}}\cdot\frac{(8,69+8,7)\cdot(17,98+1,21)\cdot(14+17,98)\cdot(0,37+1,03)\cdot(6,01+0,39)\cdot(21,8+3,15)}{(8,69+1,21)\cdot(17,98+17,98)\cdot(14+1,03)\cdot(0,37+0,39)\cdot(6,01+3,15)\cdot 21,8}=$$
$$¿46\cdot\frac{17,39\cdot 19,9\cdot 21,98\cdot 1,4\cdot 6,4\cdot 24,95}{9,9\cdot 35,96\cdot 15,03\cdot 0,76\cdot 9,16\cdot 21,8}=\frac{1700430,5}{812043,7}\cdot 46=2,09\cdot 46=96,32$$

Determining the calculated amplitude of changes in outdoor air temperature: $A_{t_{out}}^{accoun.}=0,5A_{t_{out}}+\frac{\rho(J_{\max}-J_{mid})}{\alpha_{out}}=0,5\cdot 23,1+\frac{0,45\cdot(746-172)}{21,8}=11,55+11,85=23,4^0C.$ The calculated amplitude of temperature changes on the inner surface of the barrier structure is determined using the following formula: $A_{\tau_B}=\frac{A_{t_H}^{расч}}{v}=\frac{23,4}{96,32}=0,24\,{}^0C$

Determine the required value of this amplitude using the following formula: $A_{\tau_B}^{TP}=2,5-0,1(t_H-21)=2,5-0,1(28-21)=16,8^0C.$ Let's check if the condition is met: $A_{\tau_B}\leq A_{\tau_B}^{TP}$; $A_{\tau_B}=0,24\,{}^0C<A_{\tau_B}^{TP}=16,8\,{}^0C$ the condition is met.

Therefore, From the results of the above-mentioned theoretical thermal-physical calculations, it can be concluded that during the repair of the external wall structure of the 4-floor reinforced concrete panel public building in operation in the city of Jizzah, it is possible to increase its heat resistance by covering it with a 5 cm thick basalt facade plate.

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