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ЗБІРНИК ТЕЗ ДОПОВІДЕЙ

XX МІЖНАРОДНОЇ КОНФЕРЕНЦІЇ НАУКОВО-ПЕДАГОГІЧНИХ ПРАЦІВНИКІВ, НАУКОВИХ СПІВРОБІТНИКІВ ТА АСПІРАНТІВ «ПРОБЛЕМИ ТА ПЕРСПЕКТИВИ РОЗВИТКУ ТЕХНІЧНИХ ТА БІОЕНЕРГЕТИЧНИХ СИСТЕМ ПРИРОДОКОРИСТУВАННЯ: КОНСТРУЮВАННЯ ТА ДИЗАЙН»

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CALCULATION OF THE HEAT TRANSFER RESISTANCE OF THE RESIDENTIAL BUILDING'S THERMAL INSULATION SHELL

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There is a tendency to optimize the thermal protection of external enclosure structures - one of which is the method of calculating the thickness of thermal insulation of structures "by minimizing the reduced energy consumption". This takes into account the simultaneous costs for the production of structures, the technology of building construction and operating costs for their use. For exterior enclosures in the thesis work a certain number of requirements, namely: high level of thermal protection in the cold period of the year, high level of heat resistance, low energy intensity of materials of the inner layers during fluctuations of heat flow in the middle of the room, airtightness.

Modern insulation systems provide for the creation of complex protective shells around the structures of buildings, which include the insulation of the structures in contact with the soil in conjunction with the insulation of the coatings. This set of measures eliminates the appearance of cold bridges, increases the thermal resistance of the enclosure structures, and prevents condensation.

In this work the construction of residential building in Shevchenkivskyi district, Kyiv is considered. All trends of development, comfortable stay of residents and visitors are taken into account.

The urgent problem of modern construction is the need to develop a building energy passport with the determination of energy efficiency class.

The object of research is the spatial temperature field of a complex heat-insulating protective shell of a residential building.

The subject of research is optimization parameters of thermal protection of external enclosing structures using the method "for minimization of reduced energy consumption".

Energy efficiency of a building - the property of the building, its structural elements and engineering equipment to provide for the life cycle of the building human life needs and optimal microclimatic conditions for its stay and/or living in the premises of the building of the building with the normally permissible (optimum) level of energy costs, energy resources lighting, ventilation, air conditioning, hot water supply, taking into account local climatic conditions.

Enclosures are building structures that create a heat-insulating shell of the residential building to maintain heat for heating and/or cooling the premises, to protect against climatic influences, to divide the residential building into separate parts or to rooms with different temperature and humidity conditions.

The minimum values that characterize the ability of a building, its structural elements and engineering equipment (including the permissible energy consumption per unit of heated (air-conditioned) area or volume of a building, determined on the basis of economically justified level of energy efficiency of the building) cycle of the building to meet human needs and create optimal microclimatic conditions for his/her stay and/or accommodation in such premises is defined as the minimum requirements for the energy efficiency of buildings.

The design compactness of the building is entered, which is determined by the ratio of the total area of the inner surfaces of the enclosing structures to the air-conditioned heated building (cooled).

$$A_{bci} = \frac{A_{\Sigma}}{V}; \tag{1}$$

where A_{Σ} - the total area of the inner surfaces of external enclosures, including the upper floor covering (overlapping) and the lower heating room flooring (floor), m^2; V - air-conditioned volume for a public building (or part thereof), m^3, determined according to ДСТУ Б EN ISO 13790.

When designing new buildings, reconstructing and overhauling layers of insulating materials should be placed on the outside of the supporting walls.

The presence of thermally conductive inclusions in the fence causes the temperature in its thickness to change in two or even three directions. In this case, you have to deal with a two-dimensional (flat) or three-dimensional field.

In building enclosures, a fiat temperature field arises in the presence of frame elements, rows, jumpers, etc. when their length exceeds the thickness of the fence considerably. In this case, taking the length of the frame members infinitely large, we will have the case of a flat temperature field in which the temperature distribution in all planes parallel to the cross-sectional plane of the element under consideration will be the same.

The differential equation for a flat temperature field in a rectangular 0xy coordinate system is:

$$\frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} = 0; \tag{2}$$

Analytical integration of this equation is a rather difficult task, which is further complicated by the presence in the field of materials with different coefficients of thermal conductivity. Usually the problem is solved by numerical integration in finite differences. In this case, the differential equation is replaced by a system of ordinary linear equations in which the values of the temperatures at the points of the field located at the nodes of the square grid with the side of the square equal to the accepted size Δ are unknown. The grid is chosen so that the direction of one side is parallel and the other perpendicular to the main direction of movement of the heat flow.

In a fixed temperature field, the sum of the amount of heat transmitted from a node with coordinates x to adjacent nodes must be zero. From this condition, the most common expression for temperature can be found $\tau_{x,y}$, K, in the node with coordinates x,y:

$$\tau_{x,y} = \frac{k_{x-\Delta} \cdot \tau_{x-\Delta y} + k_{y+\Delta} \cdot \tau_{x,y+\Delta} + k_{x+\Delta} \cdot \tau_{x+\Delta y} + k_{y-\Delta} \cdot \tau_{x,y-\Delta}}{k_{x-\Delta} + k_{y+\Delta} + k_{x+\Delta} + k_{y-\Delta}};$$

where $\tau_{x-\Delta,y}$, $\tau_{x,y+\Delta}$, $\tau_{x+\Delta,y}$, $\tau_{x,\ y-\Delta}$ – temperature at adjacent grid nodes, K;
$k_{x-\Delta}$, $k_{y+\Delta}$, $k_{x+\Delta}$, $k_{y-\Delta}$ – coefficients of heat transfer in the direction of the grid sides between the point x, y and adjacent points, W/(м^2·K).

Conductivity of the reinforced concrete wall and insulation

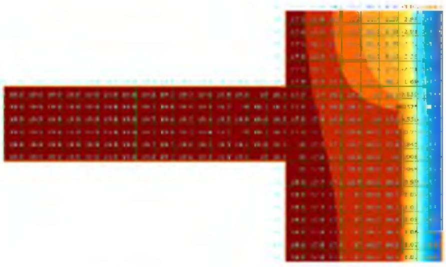

Fig. 1. Scheme of the thermal conductivity in LIRA-SAPR (variant 1)

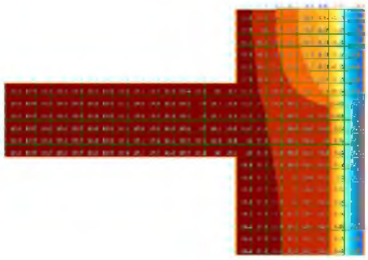

Fig. 2. Scheme of the thermal conductivity in LIRA-SAPR (variant 2)

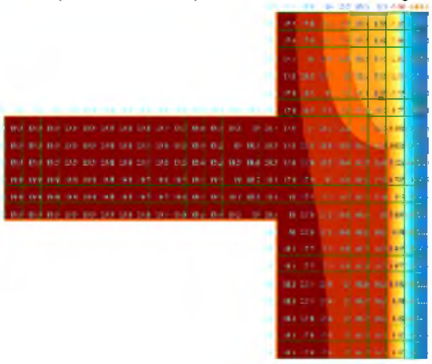

Fig. 3. Scheme of the thermal conductivity in LIRA-SAPR (variant 3)

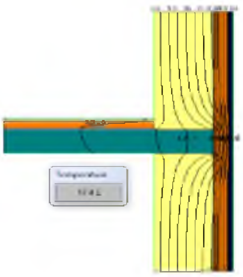

Fig. 4. Scheme of the thermal conductivity in THERM-6 (variant 1)

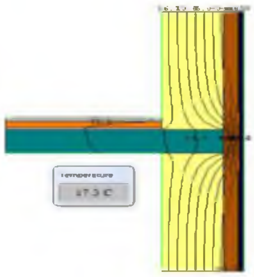

Fig. 5. Scheme of the thermal conductivity in THERM-6 (variant 2)

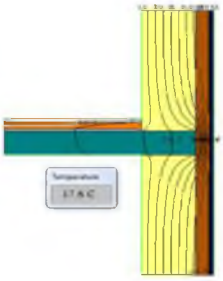

Fig. 6. Scheme of the thermal conductivity in THERM-6 (variant 3)

Table 1.

Comparison table of the calculation thermal conductivity

Variant number		LIRA-SAPR, (°C)	THERM-6, (°C)
Outside	1	-0.8	-2.1
	2	+0.2	-1.9
	3	+0.5	-1.5
In the middle	1	+18.7	+17.4
	2	+18.6	+17.3
	3	+19.0	+17.6
Inside	1	+19.8	+19.3
	2	+19.8	+19.4
	3	+20.0	+19.6

So, taking the LIRA-SAPR software as a basis, we can compare it with the simplest program for calculating the thermal conductivity of THERM-6 elements. In this work there are three options for building enclosing structures and their efficiency at fixed temperatures (static problem). The results of calculation are shown on Fig. 1-3 (for LIRA-SAPR) and Fig. 4-6 (for THERM-6).