WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 10, Oct., 2022

ANALYSIS OF THE RESULTS OF HEAT PROTECTION OF OPERATING RESIDENTIAL BUILDINGS FROM AERATED CONCRETE BLOCKS

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Annotatsiya
Maqolada teplovizion tadqiqotlar o'tkazilgan bo'lib tadqiqot asosida issiqlik o'tkazuvchanlikka qarshiliklar, tashqi devordan yuqoladigan solishtirma issiqlik sarfi strukturasi aniqlangan.

Abstract
In the article, thermal imaging studies were carried out, on the basis of which the resistance to thermal conductivity, the structure of relative heat losses from the outer wall were determined.

Аннотация
В статье были проведены тепловизионные исследования, на основании которых определено сопротивление теплопроводности, структура относительных потерь тепла с наружной стены..

Keywords: building, walls autoclaved aerated concrete aerated concrete blocks, thermal conductivity, thermal resistance, energy saving, energy efficiency.

Kalit so'zlar: бино, девор автоклав гозоблок, газоблок блоки,иссиклик утказувчанлик, терма каршилик,енергия каршилик ,енергия тежаш

Ключевые слова: здание, стены, автоклавный газобетон, газобетонные блоки, теплопроводность, термическое сопротивление, энергосбережение, энергетическая эффективност.

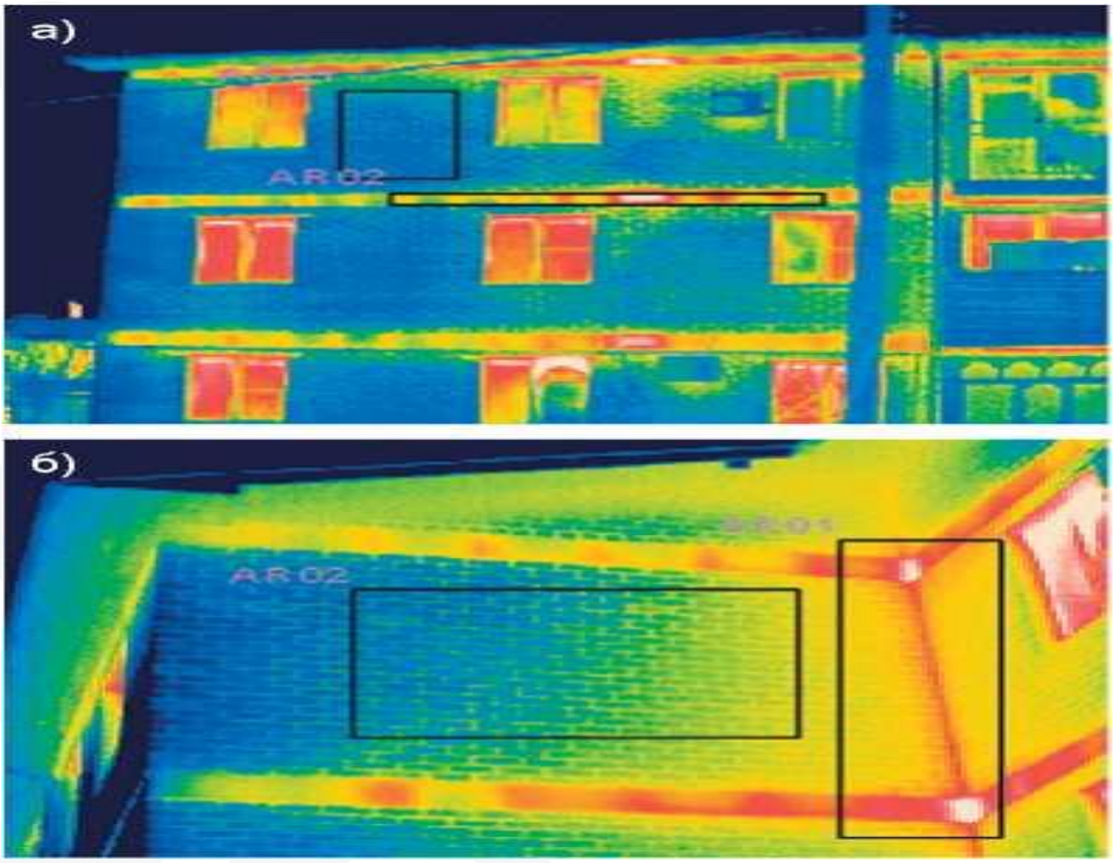
Introduction

Let us analyze the results of full-scale tests of thermal protection of buildings made of aerated concrete blocks located in Tashkent. We will show that for the construction area under consideration (two-layer external walls without additional thermal insulation have practically no reserve for thermal protection and energy saving.

Results of Thermal Imaging Control

The thermograms obtained during the thermal imaging survey made it possible to visually identify temperature anomalies and identify defects in the edge zones of building envelopes (Pic. 1). A detailed analysis of thermal defects was performed in [1, 2]. The presence of temperature anomalies and defects in the edge zones ofenclosing structures leads to:

- lowering the temperature on the inner surface of the enclosing structures (radiation temperature);
- deterioration of indoor microclimate parameters;
- to reduce the thermal uniformity of the outer walls;
- an increase in heat loss through the cladding during the cold season.



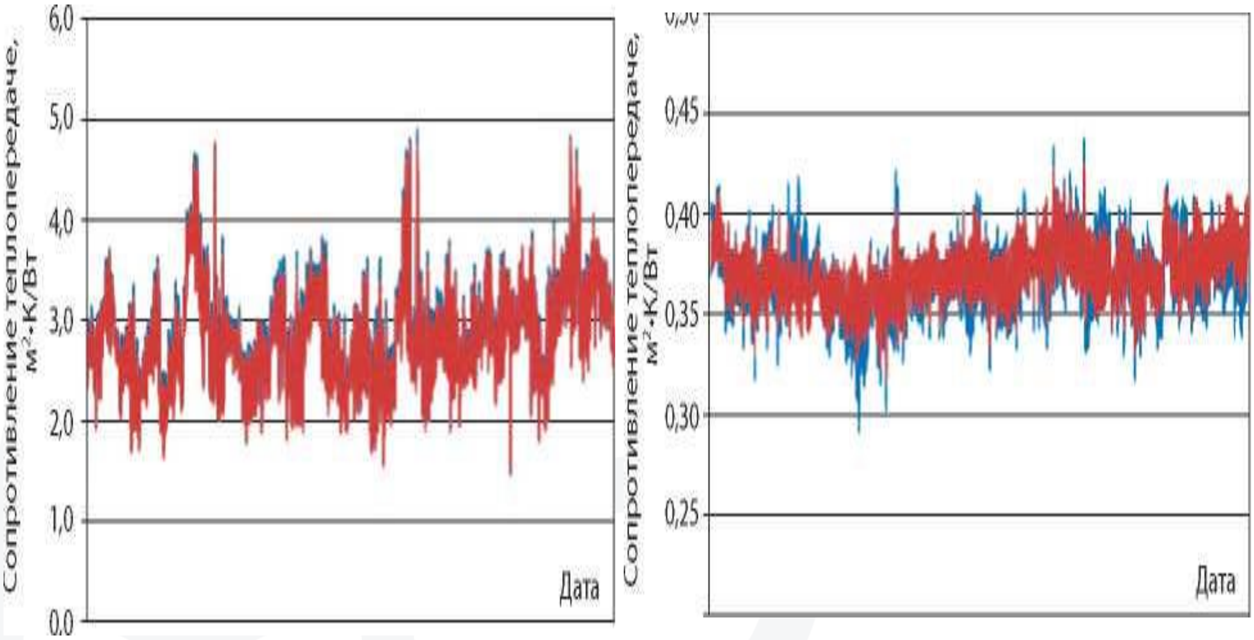
Pic. 1. Thermogram a) a fragment of the facade of the building; b) outgoing and incoming angles. resistance to heat transfer, measured in different parts of the enclosing structures (Table 3), fluctuate over a wide range, which indicates a high unequal efficiency of the heat shield of the shell. In the edge zones of the enclosing structures, the heat-shielding

The results of thermal imaging control are valuable information necessary for the correct assessment of the level of thermal protection of buildings. They allow you to correctly select the edge zones of the enclosing structures for thermal calculation.

The results of measurements of resistance to heat transfer of enclosing structures

The results of measuring the resistance to heat transfer at various points of the heat-shielding shell of the building are shown in pic. 2.

The results of measuring the resistance to heat transfer of the enclosing structures of the surveyed group of buildings are given in (Table 1). Based on the measurements, an element-by-element assessment of the thermal protection of buildings was made



Pic. 2. Results of measurements of resistance to heat transfer a) at the point of the outer wall (building 1, apt. 2); b) in the central part of the double-glazed window (building 1, apt. 4)

Table 1 Actual values of heat transfer resistance of enclosing structures

Number building	Number apartments	Actual resistance to heat transfer, m2 •K/W			
		outer wall	double glazing	attic floors	ceilings above the technical underground
1	1	1,85 ± 0,29	0,40 ± 0,02	-	2,64 ± 0,40
	2	2,89 ± 0,40	0,64 ± 0,19	-	3,34 ± 0,62
	3	2,12 ± 0,38	-	-	1,87 ± 0,55
	4	2,01 ± 0,53	0,40 ± 0,02	2,17 ± 0,55	-
2	5	0,95 ± 0,11	0,37 ± 0,01	-	-
	6	1,06 ± 0,13	0,31 ± 0,06	-	-
	7	2,30 ± 0,27	0,34 ± 0,02	0,76 ± 0,15	-
	8	2,00 ± 0,35	-	1,45 ± 0,22	-
3	9	1,59 ± 0,24	-	0,63 ± 0,07	-

Table 2. Element-by-element assessment of thermal protection of buildings based on measurement results

Enclosing structure	Heat transfer resistance, m2, K/W	
	minimum allowable	actual (measured))
Exterior walls	1,75	0,95-2,89
Window	0,42	0,31-0,64
Attic floor	2,94	0,63-2,17
Overlapping over the technical underground	2,94	1,87-3,34

Based on the measured values of the resistance to heat transfer of enclosing structures (Table 1) and the geometric characteristics of buildings, the calculation of specific heat fluxes through the building envelope was performed:

■ through external walls - 579 Vt/K;
■ through windows, balcony doors - 624 Vt/K;
■ through the attic floor - 502 Vt/K;
■ through the ceiling above the technical underground - 160 Vt/K.

As can be seen, most of the heat loss (64%) is carried out through the facades of buildings, which is explained by the significant influence of the edge zones of the outer walls, as well as the low heat-shielding properties of window blocks. A significant proportion of heat loss through the attic floor (27%) is due to the relatively low level of thermal insulation of this design.

The estimated value of the actual specific heat-shielding characteristics of the building is 0.307 W / (m^3 • K), which is more than the normalized value of 0.257 W / (m^3.K). Thus, the complex regulatory requirement is not fulfilled.

Checking the enclosing structures for sanitary and hygienic parameters showed their non-compliance with this requirement. In many cases, the temperature on the inner surface of the enclosing structures in the edge zones was below the dew point of the indoor air during the cold period of the year. As a result, moisture condensation and the formation of mold fungi occur [1]. The most dangerous are the junctions of a column with an interfloor overlap and a window block with a wall opening (Pic. 3).

Thus, according to the results of field measurements, it was established that the actual level of thermal protection of buildings does not meet the current requirements of СНиПа [3].

Estimated assessment of the level of thermal protection of buildings based on design data

In order to identify the causes of the occurrence of temperature anomalies and thermal defects in the building envelope, a calculated assessment of the level of thermal protection of buildings was made on the basis of design data.

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ISSN: 2776-0979, Volume 3, Issue 10, Oct., 2022

Pic. 3. Condensation of moisture and the formation of molds on the inner surface of the junction a) columns with interfloor overlap; b) a window block with a wall opening

As an example, the assessment of the thermal regime of the outer walls is carried out in detail.

The main feature of the outer walls of aerated concrete blocks is the presence of numerous edge zones identified on the basis of thermal imaging control (Pic. 1). Not taking into account the edge zones when designing building envelopes can lead to significant errors in determining their heat-shielding characteristics.

Mathematical modeling of the thermal regime of the structure in the cold period of the year was performed under the following boundary conditions:

- design temperature of the internal air of the building t,= 20 °C;
- calculated outdoor temperature text = -18°C;
- design coefficient of heat transfer at the inner surface of the building envelope asi = 5.7 Vt/(m^2 •K);
- calculated heat transfer coefficient at the outer surface of the structure ase = 23 Vt/(m^2.K).

The following types of edge zones are taken into account in the calculation:

- junction of external walls with interfloor ceilings;
- junction of window blocks with wall openings;
- the corner of the outer walls coming out of the room;
- the corner of the outer walls entering the room;
- junction of the column with the walls;

■ junction of external walls with overlapping above the technical underground;
■ junction of outer walls with attic flooring.

Due to the insignificant effect of flexible connections on the temperature field of the outer walls, according to the results of thermal imaging control, flexible connections were not taken into account in the heat engineering calculation.

Table 3 Results of calculation of the thermal regime of external walls

Index	Meaning
Main specific heat flux Q_{bas}, Vt/K	442,00
Additional specific heat flux through the edge zones Q^{ad}, Vt/K, including through:	132,00
- junctions of external walls with interfloor ceilings Q_1^{ad}	48,10
- junctions of window blocks with wall openings Q_2^{ad}:	35,60
- exit corners Q_3^{ad}	4,08
- corners included in the premises Q_4^{ad}	-3,95
- junctions of columns with walls Q_5^{ad}	2,51
- interface nodes of external walls with overlapping above the technical underground Q_6^{ad}	21,00
- junctions of external walls with an attic floor Q_7^{ad}	24,20
Total heat flow Q_{sum}, Vt/K	574,00

▪ The scheme of the constructive solution of the wall according to the project is shown in (Pic. 4). The calculation used the heat-technical characteristics of building materials[9]. Based on the results of calculating the thermal regime of wall structures (Table 3), the structure of specific heat losses through the outer walls was determined:

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■ main heat losses - 77%;
■ additional heat losses:
- through the junctions of the outer walls with interfloor ceilings - 8%;
- through the junctions of window blocks with wall openings - 6%;
- through the junctions of the outer walls with the ceiling above the technical underground - 4%;
- through the junctions of the outer walls with the attic floor - 4%;
■ others - 1%.

Analysis of the Results

Analysis of the research results shows that 23% of heat losses occur through the edge zones. Most of the heat loss is noted through the junctions of the outer walls with the interfloor ceilings, which is due to the perforation device in the ceilings. Together with heat losses through the junctions of window blocks with wall openings, they characterize most of the additional heat losses - 14%. Smaller heat losses through the junctions of the outer walls with the floor above the technical underground and with the attic floor are due to the shorter length of these nodes.

The calculated reduced heat transfer resistance of the outer walls R o® "is equal to 1.88 m^2 • K / Vt, which is close to the minimum allowable value R ™n (1.75 m^2 K / Vt). Approximation R o®" to R creates thermal risks during the design of the building envelope. The rather low value of the coefficient of thermal engineering uniformity of the outer walls (r = 0.774) is due to the significant influence of the edge zones.

The results of the evaluation of the thermal protection of the building envelope

Проектный уровень теплозащиты ограждающих конструкций отвечает current element-by-element requirements (Table 4).

The calculated specific heat-shielding characteristic of buildings, obtained on the basis of design data, is 0.228 Vt / (m^3. K), which is less than the normalized value of 0.257 Vt/ (m^3. K); consequently, the design solution of buildings meets the complex requirement for thermal protection.

The temperature of the inner surface of the enclosing structures in places of heat-conducting inclusions is higher than the dew point of the internal air at the design temperature of the outside air, therefore, the design solution of the enclosing structures meets the sanitary and hygienic requirement.

Thus, on the basis of the conducted full-scale thermophysical tests of residential buildings made of aerated concrete blocks and verification heat engineering

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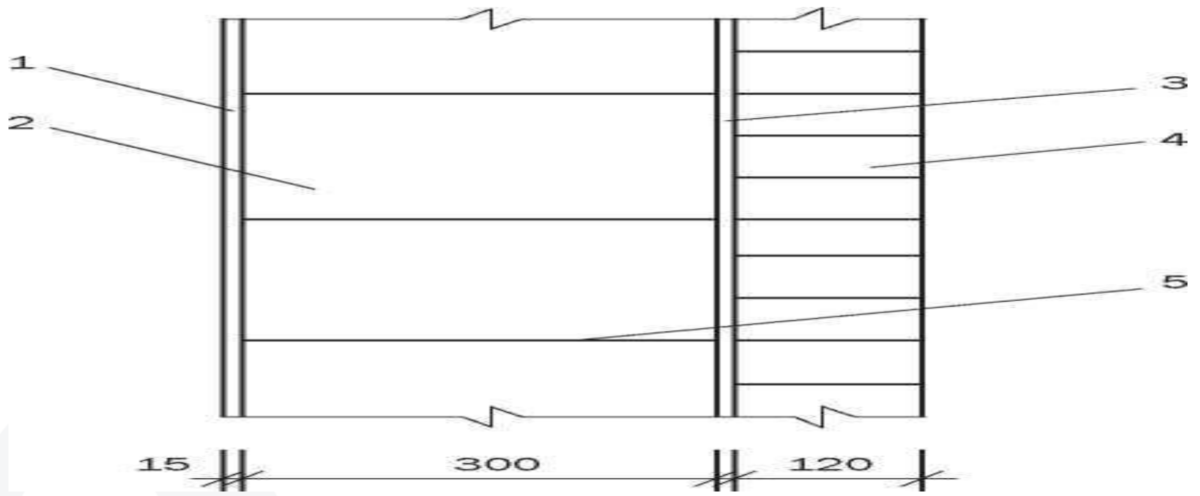
calculations, it was established that the actual level of thermal protection of buildings is lower than the design one. This is due to both numerous unauthorized deviations from the project, allowed by the contractor during construction, and poor-quality performance of construction and installation works. The project itself carries certain thermal risks associated with not taking into account the influence of edge zones on the heat-shielding properties of enclosing structures.



1 - plaster - 2 aerated concrete block masonry 3 technological gap 4 - front brick 5 - glue line
2 Pic. 4. Section of the wall along the "smooth

Table 4. Element-by-element assessment of the thermal protection of the building envelope based on design data

Enclosing structure	Rated resistance to heat transfer, m2.K/Vt		Estimated resistance to heat transfer, m² •K/W
	The minimum allowable level of thermal protection	Basic level of thermal protection	
Exterior walls	1,75	2,77	1,88
Window	0,42	0,44	0,50
Attic floor	2,94	3,67	3,84
overlap over	2,94	3,67	3,08

To ensure the design level of thermal protection of the object, it is necessary to eliminate the discrepancy between the project and the actually performed work. Particular attention should be paid to the improvement of the constructive solution of the edge zones [1]. The use of external additional thermal insulation along the entire plane of the wall, as shown by preliminary calculations, evens out the temperature field. At the same time, not only additional heat losses in the edge zones are reduced, but also the main heat losses of the wall. It is necessary to replace the window blocks with single-chamber double-glazed windows installed in buildings with more energy-efficient translucent enclosing structures. It is also necessary to increase the level of thermal protection of the ceiling above the technical underground and the attic floor. These measures to improve the heat-shielding properties of buildings can only be solved within the framework of the development of a project for the reconstruction of buildings.

Recommendations

The design of two-layer external walls in the form of autoclaved aerated concrete masonry with external brickwork cladding carries thermal risks associated with an increase in the unequal efficiency of the thermal protection of the building envelope, due to a significant effect on the thermal protection of buildings of the edge zones. At the same time, the influence of two- and three-dimensional elements in the structure increases significantly, the uneven distribution of temperature on its inner surface, and the thermotechnical uniformity of enclosing structures decreases. To take into account the influence of edge zones, it is necessary to calculate three-dimensional temperature fields and develop new design solutions.

The design level of thermal insulation of these structures can be focused on the minimum allowable element-by-element requirements for thermal protection only if the requirements for the specific characteristic of thermal energy consumption for heating and ventilation of the building are met and does not correspond to the basic level of thermal protection for most regions of the Republic. To achieve a reserve for thermal protection and energy saving, additional thermal insulation is required for two-layer external walls.

In order to reduce thermal risks in the design of the buildings under consideration, it is necessary, first of all, to improve the constructive solution of the edge zones of the shell. Another measure to increase the level of thermal protection of buildings is the use of additional thermal insulation over the entire plane of the wall. As preliminary calculations show, in this case, the temperature field is leveled, not only additional heat losses in the edge zones are reduced, but also the main heat losses of the wall.

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