IMPROVING ENERGY EFFICIENCY IN RESIDENTIAL BUILDINGS BY ENHANCING THE THERMAL PROTECTION OF ENCLOSING STRUCTURES

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Abstract

This thesis examines the issues of improving energy efficiency in residential buildings by enhancing the thermal protection of enclosing structures. The study analyzes heat losses occurring through external walls, roof covering, window and door structures and substantiates the technical and economic significance of using modern thermal insulation materials. The “Chashma Residence” residential complex located in Tashkent was selected as the object of the study. The obtained results show that the comprehensive modernization of enclosing structures makes it possible to reduce heat losses, improve the indoor microclimate and ensure the rational use of energy resources.

Keywords: residential building, energy efficiency, enclosing structure, thermal protection, heat losses, mineral wool, energy-saving materials, thermal insulation.

Introduction

Under current conditions, the rational use of energy resources in buildings, reduction of heat losses and improvement of living comfort are among the important tasks of the construction and municipal sectors. In residential buildings, a large share of energy consumption is associated with maintaining the standard indoor temperature, that is, with heating and cooling processes. If the thermal protection of the building envelope is insufficient, a certain part of the consumed energy is lost to the external

environment through walls, roof covering, windows, doors and other enclosing elements.

This issue is even more relevant in the climate of Uzbekistan. A considerable amount of energy is required for heating buildings in winter and for cooling them in summer. Therefore, improving the thermal protection of enclosing structures in residential buildings is one of the effective directions of energy saving. The “Chashma Residence” residential complex located in Tashkent was selected as the object of the study, and the thermal-technical condition of its external walls, roof covering, window and door structures was analyzed.

Research methodology

The study used methods for assessing the thermal-technical condition of enclosing structures, analyzing the thermal conductivity properties of materials, comparing heat losses in the existing and proposed conditions, and determining the economic efficiency of energy-saving measures. The main attention was paid to heat losses through external walls, roof covering, windows and doors.

The thermal protection of an enclosing structure was evaluated depending on the thickness of material layers, the thermal conductivity coefficient, the overall resistance to heat transfer, the area of the structure and the difference between indoor and outdoor temperatures. The study also considered the possibilities of using mineral wool, energy-efficient glazing units and door structures with enhanced thermal protection.

Main part

Enclosing structures are the main elements that determine the heat exchange of a building with the external environment. They include external walls, roof covering, intermediate floor slabs, windows and doors. The higher the heat transfer resistance of these elements, the more stable the indoor temperature remains and the lower the load on the heating system becomes.

In residential buildings, external walls are usually the structures with the largest surface area. Therefore, reducing heat losses through external walls has a significant effect on overall energy efficiency. In the case of the “Chashma Residence” object, the use of materials such as aerated concrete blocks and mineral wool in external walls serves to improve the thermal protection of the building. Mineral wool is considered a suitable material for use in multi-storey residential buildings because it has low thermal conductivity, fire resistance and vapor permeability properties.

Window structures are also an important part of the thermal envelope of a building. Although they provide natural lighting and insolation, their heat transfer resistance is lower than that of walls. Therefore, heat losses through windows can be reduced by using energy-efficient glazing units, multi-chamber profiles and high-quality sealing elements. In particular, glazing units with Low-E coating and argon filling increase heat retention efficiency.

Heat losses through roof covering and upper floor slabs are also important. Since warm air rises upward, heat losses increase in winter if the roof covering is not sufficiently insulated. Therefore, strengthening the roof and covering parts with mineral wool, extruded polystyrene foam or other effective insulation materials improves the overall heat balance.

Insufficient airtightness in door structures increases infiltration losses. The use of door blocks with enhanced thermal protection, vestibules and high-quality seals in entrance groups reduces the inflow of cold air. Thus, improving each element of the enclosing structures not separately, but in a comprehensive manner, provides a higher result.

Results and discussion

According to the results of the study, improving the thermal protection of enclosing structures can significantly reduce the heat losses of a residential building. Based on the calculation results, it was shown that after energy-saving measures the

total heat losses decrease from 25.41 kW to 16.24 kW. This is equal to 9.175 kW of prevented heat losses, while the relative reduction is approximately 36.1%.

Table 1. Recommended thermal insulation materials for enclosing structures

Material name	Application area	Thermal-technical characteristics	Material view
Mineral wool (basalt fiber)	External walls, facades and roof structures	λ ≈ 0.035–0.045 W/(m·°C); non-combustible; vapor-permeable; good sound insulation.	
Extruded polystyrene foam (XPS)	Roof, underground parts (basement), floor and areas exposed to moisture	λ ≈ 0.029–0.035 W/(m·°C); moisture-resistant; mechanically strong.	
Expanded polystyrene (EPS)	Facades, slabs and additional thermal insulation layers	λ ≈ 0.032–0.042 W/(m·°C); lightweight; easy to install.	
Polyurethane foam (PUR)	Spray-applied insulation for walls and roof structures	λ ≈ 0.022–0.028 W/(m·°C); forms a seamless (monolithic) layer; highly efficient thermal insulation.	

Ecowool (cellulose insulation)	Internal cavities, attic spaces, frame structures	$\lambda \approx 0.038–0.042$ W/(m·°C); environmentally friendly; good sound insulation.	

As can be seen from the table, when selecting materials to improve the energy efficiency of residential buildings, it is necessary to take into account not only thermal conductivity, but also fire safety, moisture resistance, vapor permeability, ease of installation and suitability for operating conditions. Therefore, it is advisable to use mineral wool for external walls, extruded polystyrene foam for roofs and areas with high moisture exposure, and modern insulation materials with low thermal conductivity for facades and coverings in an integrated manner.

Conclusion

Improving the thermal protection of enclosing structures is of great practical importance in increasing the energy efficiency of residential buildings. Modernization of external walls, roof covering, windows and doors based on modern thermal insulation materials reduces heat losses, ensures the stability of indoor temperature and improves living comfort.

The results obtained from the example of the “Chashma Residence” residential complex show that the integrated use of mineral wool, energy-efficient window blocks and door structures with enhanced thermal protection can reduce heat losses by up to 36.1%. Therefore, these solutions are technically, economically and socially appropriate for the modernization of residential buildings.

References

1. Law of the Republic of Uzbekistan “On Energy Saving, Its Rational Use and Improvement of Energy Efficiency”.

2. Resolution of the President of the Republic of Uzbekistan No. PQ-4477 dated October 4, 2019 “On Approval of the Strategy for the Transition of the Republic of Uzbekistan to a Green Economy for 2019–2030”.
3. The World Bank. Clean Energy for Buildings in Uzbekistan. Washington, DC: World Bank, 2022.
4. International Energy Agency. Uzbekistan 2022: Energy Policy Review. Paris: IEA, 2022.
5. UNECE. Country Profiles on the Housing Sector: Uzbekistan. Geneva: United Nations Economic Commission for Europe, 2015.
6. SP 50.13330.2012. Thermal Protection of Buildings. Updated edition of SNiP 23-02-2003. — Moscow, 2012.
7. SP 131.13330.2020. Building Climatology. — Moscow, 2020.
8. Bogoslovsky V.N. Building Thermophysics. — Moscow: ASV, 2006.
9. Fokin K.F. Building Heat Engineering of Enclosing Parts of Buildings. — Moscow: AVOK-PRESS, 2006.
10. Tabunshchikov Yu.A., Brodach M.M., Shilkin N.V. Energy-Efficient Buildings. — Moscow: AVOK-PRESS, 2003.