POLITECHNIKA ŚLĄSKA
WYDZIAŁ INŻYNIERII ŚRODOWISKA I ENERGETYKI

DOSKONALENIE OGRZEWANIA I WENTYLACJI PASYWNYCH BUDYNKÓW MIESZKALNYCH

Rozprawa doktorska

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Abstract

The emergence of the idea of passive buildings was determined by the growing awareness of the impact of human activities on the environment and the desire to save energy for heating or minimizing the operating costs of the building. Designing and constructing energy-efficient buildings, especially passive ones, is far more complicated compared to designing traditional buildings. It seems impossible to properly design such a building in the absence of cooperation of designers from various industries. It is necessary to look at the building, its construction, installation and equipment, as a system of connected vessels. Such structures are extremely sensitive to design and implementation errors.

The aim of the dissertation was to develop the principles of shaping selected structural elements and the heating and ventilation system of a typical passive single-family building located in Poland. The selected structural elements were the glazing surface of the southern facade and the way windows are shaded. The following specific objectives were adopted:

- Determination of the optimal glazing surface of the walls of a passive building: adoption of a procedure, research schedule and analysis of the results with conclusions.
- Analysis of the existing State of heating and ventilation methods of passive residential buildings: establishing the courses of action to improve heating and ventilation of residential passive buildings.
- Proposing modified heating systems, their energy and economic assessment and analysis of the results with conclusions.
- Formulation of conclusions including the identification of the most advantageous Solutions among the presented analyses.

For the purpose of the analysis of the improvement of heating and ventilation of a single-family passive residential building, an exemplary two-storey house was adopted. The construction of partitions was established in accordance with the requirements for passive buildings. This applied to the construction of external walls, windows, roofs, the floor on the ground. The climate data, prepared on the basis of long-term meteorological observations, were used in the calculations.

The experience gained in the course of the study and analytical work in the field of passive buildings allowed to formulate the following general conclusions:

1. The most advantageous surface of south facade windows depends on the use of active shading. The lowest costs of using the building were obtained for the case in which the surface corresponded to 70% of the south facade surface and active shading in the form of internal fabric blinds was used. This case was also the most favourable in terms of environmental impact.

2. The analysis of the operation of the heating, ventilation and cooling system yielded the following results:

- the building without cooling: installation solution number 3 (system in which the heat pump condenser was located in the hot water tank that heats up the working medium of the heating system through a plate heat exchanger), window height 2,31 m, 60% coverage of the south facade by windows,
- the building with cooling: installation solution number 5 (in which the heat pump condenser transfers energy to the medium supplying the hot water tank and heat buffer using a three-way valve), window height 2,31 m, 65-70% coverage of the south facade by windows.

It has been shown that the introduction of fixed shading (eaves roof or balcony) does not have a beneficial effect – it reduces the energy expenditure on cooling in a negligible degree while increasing whole-life costs.

3. It is possible in Polish climate conditions to erect a building that meets the requirements for passive buildings, but it seems right to equip such a building with a heating system using capillary mats, which also enables cooling