Summary

Title:

MODULAR PASSIVE HOUSE FROM PRECAST CONCRETE ELEMENTS PRODUCED BY BETARD FOR APPLICATION IN RESIDENTIAL AND PUBLIC BUILDINGS

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Energy-efficient buildings are becoming increasingly popular among investors in both residential and public construction. In particular, they are characterized by low demand for energy for heating and the use of renewable energy sources.

Betard company, as one of the market leaders in the production of precast concrete elements, understanding the idea of sustainable building, has developed and introduced a three-layer wall with high-quality thermal insulation to the market in the form of a PIR board and the heat transfer coefficient of the partition meeting not only the Technical Conditions, but also the requirements of passive houses.

The scientific problem of this doctoral dissertation was to answer the question whether using the Betard product in the form of three-layer walls, the analysed building can meet the requirements of passive houses and current Technical Conditions. Another scientific problem was to define the impact of climate change on meeting these requirements and determining the payback period for additional investment outlays.

The doctoral dissertation introduces a critical analysis of the literature on the subject. To determine the thermal conductivity coefficient of the concrete layers of Betard's three-layer wall, tests were carried out in a plate apparatus with covered heating plate. 12 samples in the form of concrete slabs with dimensions of 300x300x30mm were used for the test. Based on the results, in accordance with the applicable standard, the declared value of the thermal conductivity coefficient of the concrete layers of the three-layer wall was determined as 0.59 W/(mK).

Then, the heat transfer coefficients of all building envelopes were determined and the building was also checked for the possibility of thermal bridges. Thermal and humidity tests of the external wall were also performed. Based on them, it was verified that no mold would develop on the internal surface of the partition, and condensation of water vapor occurring inside the partition in winter did not pose a threat to the structure.

A building model was developed in the design and building modeling software - SketchUp, and parameters for this model were determined by defining external partitions, climate data and building orientation. Using the energy

simulation plug-in - DesignPH, an energy simulation of the building was performed and the obtained results were exported to a PHPP excel sheet. The original building did not meet the requirements of a passive building, so a way to meet them was determined by using solutions such as increasing the insulation in the external wall from 12 to 18 cm, replacing the windows with windows with a better heat transfer coefficient U_g and U_f, as well as a more favorable g coefficient, using ventilation with heat recovery with the efficiency of 89% and the installation of photovoltaic panels to reduce the demand for primary energy. By performing another energy simulation with defined modifications, results were obtained which indicated that all required parameters of passive house and Technical Conditions were met.

In the next stage of the research, the current climate in Poland was analysed on a sample of four locations and, based on the described Representative Concentration Pathway (RCP) determined by the International Panel on Climate Change (IPCC), forecasted climate parameters were prepared for four scenarios of climate change - two for 2030 and two for 2050. As a result of the research, it was noted that there is one parameter that is likely to exceed the minimum permissible value for passive houses - the frequency of building overheating, which may result in the need to use an additional cooling system in the following years.

In the last stage of the doctoral dissertation, it was checked the payback period for additional expenditure incurred on adapting the building to the passive house standard as a result of possible savings on heating and electricity consumption. Taking into account the differences in the demand for heating energy and the use of renewable energy sources in a passive building, it was estimated that the closest possible payback will occur after 14 years.

Conclusions from research were presented as well as the proposed research directions and the practical application of the results obtained in this doctoral thesis.

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