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Application of architectural solutions in thermal modernization of existing buildings on rural areas
Zastosowanie rozwiązań architektonicznych przy termomodernizacji istniejącej zabudowy na terenach wiejskich

Key words: country dwelling house, architecture, thermal modernization
Słowa kluczowe: dom mieszkalny na wsi, architektura, termomodernizacja

Introduction

The limitation of energy consuming in country buildings can be perceived both from the aspect of newly designed buildings and also already existing. These latter mainly do not fulfill the current strict requirements on the rational energy consuming and needs an appropriate thermal modernization, i.e. improvement of existing technical features of a building which should lead first of all to reduce heat demands. This operation not only limits heat losses and heating costs but also improves the of using conditions of rooms in a building. It can be an independent modernization venture or within the frames of re-building, modernization or complete refurbishment, i.e. during other serious building changes (Robakiewicz and Gawrylczyk 1999).

There is lot of causes of excessive heating costs in already existing country buildings in Poland (Koc 2002):

– weak insulating power of baffles (walls, flat roofs, ceilings over cellars, windows, doors) which constitutes the most important cause of the excessive heat consumption,
– from the point of view of losses and potential gains of heat, unfavorable shapes and localization of buildings,
– obsolete heating system and its low energetic efficiency,
– lack of automatically controlled installation and the possibility of measurement of consumed heat,

– quite commonly occurring lack of understanding of need and usefulness of economical energy consumption.

The proper thermal modernization is extremely important. The most problems to solve occur mainly by a wall insulation. It concerns a choice of appropriate thermoinsulating materials and the insulation methods which considerably depend on the materials and methods which had served to construct the wall.

The decision about the choice of the proper method and technology of works has a big practical importance.

During undertaking thermal modernization ventures in country buildings, one should be guided by the following rules:

– to gain the full safety effect, the thermal modernization of a building structure should be realized simultaneously with the modernization of a heating system,
– the thermal modernization should be carried out simultaneously with a renovation of elevation and roof or within a complete refurbishment to reduce concise costs of insulation in a considerable way,
– there should be created better thermal properties of a building structure than the binding regulations demand,
– there should be introduced air ventilators in a window woodwork or, alternatively, a mechanical ventilation in an insulated and sealed building with changed conditions of a gravitational ventilation,
– the decision about realization and scope of the thermal modernization should be preceded by the analysis of economical efficiency (energetic audit) concerning the main aim of the thermal modernization, i.e. the reduction of consumption costs.

Method of investigations

The research work was based on two kinds of investigations – direct and indirect.

The indirect investigations consist in the reconnaissance of the topic by studying a literature concerning – in this case – the application of energy-saving solutions connected with a building structure (including architectonic solutions) during the modernization of the existing (single-family) dwelling houses.

In the direct investigations, carried out in the northern Casubia, the Author used:

– diagnostic survey realized by a free interview with proprietors of dwelling houses on the country, on the chosen by the Author region of Casubia,
– an empiric method realized by the analysis of the applied thermal modernization operations in existing houses and using an observation documented by the photographs made by herself.

Results of investigations

The region of the northern Casubia had been chosen mainly due to specific climate conditions and to a big number of preserved buildings from the beginning of the last century which could serve as examples to analyze the realized thermal modernization operations. Other feature of the region is the tourists' presence, because this region is one of the most attractive areas in terms of tourist attractiveness. The specific conditions of localization at seashore contribute to the fact that the farm tourism, trendy in

the whole Europe, develops here more and more dynamically what is connected with the expansion of dwelling houses.

The most popular way of the thermal modernization improvement in the investigated single-family houses is an insulation of external walls as well as the exchange of a window and door woodwork. The investigations carried out under the Author's management shown that the realization of an additive insulation of walls and the exchange of the window and door woodwork can bring significant profits to the investor, because the heat loss reduces by 31% (Tables 1 and 2 – Październik 2009).

There should be carried out an energetic audit for the building subjected to the thermal modernization; this audit would determine the scope as well as economical and technical parameters of the thermal modernization venture, such as simply pay back time (SPBT). There is important to point the optimal solution along with taking into consideration the costs of this venture as well as the energy saved which constitute also the assumptions to a works design (Rozporządzenie... 2008).

The architectonic constructional and thermal modernization operations in country houses are presented in the Table 3. The attention was paid to the aim and way of the realization of each solution as well as the quantity of possible energy savings and approximate payout time of the incurred costs.

TABLE 1. List of heat transfer coefficients of external walls and windows before and after thermal modernization (Październik 2009)
TABELA 1. Zestawienie współczynników przenikania ciepła ścian zewnętrznych i okien przed i po termomodernizacji (Październik 2009)

Baffle Rodzaj przegrody	Heat transfer coefficient U [W·(m^2·K)$^{-1}$] Współczynnik przenikania ciepła	
	Building before thermal modernization Budynek przed termomodernizacją	Building after thermal modernization Budynek po termomodernizacji
External walls	0,518	0,261
Windows	2,778	1,200

TABLE 2. List of the chosen building parameters before and after thermal modernization (Październik 2009)
TABELA 2. Zestawienie wybranych parametrów budynku przed i po termomodernizacji (Październik 2009)

Parameter Parametr	Building before thermal modernization Budynek przed termomodernizacją	Building after thermal modernization Budynek po termomodernizacji
Seasonal demand for heat to warm a building, Qh [kWh·rok^{-1}]	26 563	18 821
Area index of heat demand, EA [kWh·m^{-2}]	189,2	134,1
Volume index of heat demand, EV [kWh·m^{-3}]	68,76	48,72

TABLE 3. Constructive architectonic, thermal modernization operations, quantity of the possible energy savings and approximate payout time of incurred costs in country buildings[a]

TABELA 3. Budowle architektoniczne, zabiegi termomodernizacyjne, stopień możliwych oszczędności energii oraz orientacyjny czas zwrotu poniesionych nakładów w domach wiejskich

Element of architecture Rodzaj elementu architektury		Aim of thermal modernization operation Cel zabiegu termomodernizacyjnego	Way of realization of thermal modernization operation Sposób realizacji zabiegu termomodernizacyjnego	Possible savings [%] Możliwe do uzyskania oszczędności	Approximative payout time of incurred costs [years] Orientacyjny czas zwrotu poniesionych nakładów [lata]
	1	2	3	4	5
Elements of building structure	External baffles	Improvement of thermal insulation, elimination of thermal bridges	Putting of additional thermal insulation coat	10–20	8–12
	Roofs and flat roofs	Improvement of thermal insulation		5–15	6–8
	Ceilings over non-heated cellars			2–5	10–20
	Floors of the ground floor in buildings without cellar				
	Windows	Improvement of thermal insulation	Additional glass pane or foil coat, panes made of a special glass, window exchange, area reduction of window causing high heat loss	10–15	15–25
		Periodic improvement of thermal insulation	Window shutters, window blinds, curtains		
		Reduction of uncontrolled infiltration	Sealing		
	Exit doors	Improvement of thermal insulation	Insulation or exchange, vestibules		
		Reduction of uncontrolled infiltration	Sealing		

TABLE 3, cont.
TABELA 3, cd.

1	2	3	4	5
Building shape	Loggias, terraces, balconies	Creation of insulating (buffer) areas, elimination of thermal bridges	Extension – additional usable area (hothouse)	Depends on individual solution
	Roof	Creation of insulating (buffer) areas	Superstructure	
	External architectonic elements (eaves, porch, canopy, recess e.a.)	Protection of the enter zone to a heated part of building against atmospherical conditions	Extension	
Layout of rooms and functional connections between them		Creation of a warm zone from spacious rooms „opened" from the south side	Disassembly of internal walls – elimination of the traditional division into individual rooms	
Building surroundings		Reduction of unprofitable influence of climate, mainly winds	Anti-wind covers: – protection plants, – small architecture, – appropriate land configuration	
		Increase of profitable influence of climate, mainly solar radiation	Removing every possible obstacles overshadowing the southern elevation	

[a]Quantity of possible energy savings and approximate payout time of incurred costs – according directly obtained information in Respect for Energy State Agency (Krajowa Agencja Poszanowania Energii S.A.), Warsaw.

Unfortunately, in the most cases, the building extension is not coherent with the object being extended and represents totally incidental architectural form, having nothing in common with the limitation of energy consuming. Usually, the extension leads to dismembering the mass of building or to the creation of a form characteristic for energy consuming architecture from the second half of 20th century. Also, the modernization means replacing the traditional building materials with new ones, contributing to changes in colors and character of a country house (Figure 1). A similar problem can be noticed for instance in unnecessary and not finished balconies which in considerable degree affect the creation of thermal bridges. Those elements usually occur in the buildings being modernized in a urban way without taking into consideration local traditions of a rural environment.

During the investigations, there had been repeatedly observed that the protection of external walls against the unprofitable influence of the climate limits itself only to one of the building's walls and even only to its facing (Figure 2). This occurrence comes from the lack of financial resources of rural investors and is quite characteristic especially for the northern regions of Poland which do not belong to the wealthiest ones.

As a rare – unfortunately – example of the thermal modernization having essential meaning for a country building from the point of view of its architecture, there can be observed the cover with a traditional steep roof (with an attic playing a role of a thermal buffer) and protection of the enter zone against external atmospheric conditions (Figure 3). There must be emphasized that due to constructive and architectural accounts, the extension of so-called "cube-houses" from the 1960's and 1970's is difficult. If the problem is being solved within the existing storeys, it is connected to the

a b

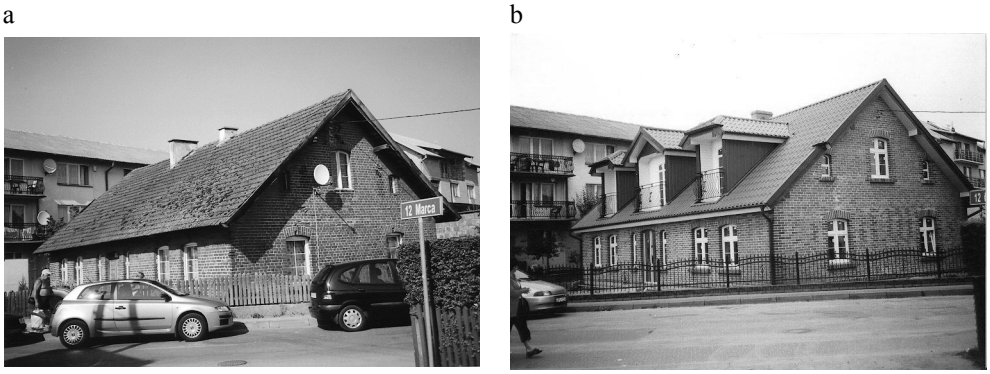

FIGURE 1. Modernization with thermal modernization of building made of red brick from the turn of 19th and 20th centuries. Some reservations can be expressed about the mansards of various covering forms, faced from inside with a white siding, as well as replacing the traditional ceramic roof tile with a metal one: a – state before modernization, b – state after modernization – Karwia, June 2005 – August 2008 (photo by Author)

RYSUNEK 1. Modernizacja z termomodernizacją budynku z czerwonej cegły z przełomu XIX i XX wieku. Zastrzeżenie budzą mansardy o różnych formach przekrycia oblicowane od wewnątrz białym sidingiem oraz zastąpienie tradycyjnej dachówki ceramicznej blachodachówką: a – stan przed modernizacją, b – stan po modernizacji – Karwia, lipiec 2005 – sierpień 2008 (fot. autor)

FIGURE 2. Clay dwelling house from the end of 19th century. Only the western wall of the building is protected against wind and rain and only with siding, without insulation. Also the wooden windows had been changed to the new, plastic – Minkowice, July 2002 (photo by Author)
RYSUNEK 2. Dom mieszkalny z gliny, z końca XIX wieku. Jedynie zachodnia strona budynku została zabezpieczona przed wiatrem i deszczem wyłącznie oblicowaniem sidingiem, bez ocieplenia. W domu wymieniono również drewniane okna na nowe plastikowe – Minkowice, lipiec 2002 (fot. autor)

FIGURE 3. Ecological thermal modernization of a building from the end of 1970's consisting in construction of a superstructure and covering the house with a step roof. An attempt of reference to tradition – a thatched gable roof with jerkin head. Some reservations can be expressed about the building enormity, resulting from the high cellar, differing from that historically developed – Minkowice, July 2008 (photo by Autor)
RYSUNEK 3. Ekologiczna termomodernizacja budynku z lat siedemdziesiątych ubiegłego wieku polegająca na nadbudowie i przekryciu domu dachem stromym. Próba nawiązania do tradycji – dach dwuspadowy naczółkowy kryty trzciną. Zastrzeżenie budzi skala budynku, wynikająca z wysokiego podpiwniczenia, odbiegająca od tej wykształconej historycznie – Minkowice, lipiec 2008 (fot. autor)

problem of high ground floor; if the investor decides to a superstructure on the existing object, usually changes this object into a tenement what causes departure from the traditional and historically developed form of country buildings.

The rational energetic economy in country houses, i.e. the reduction of their energy consumption, i.a. through properly made thermal modernization, including possible using of renewable energy sources, has nowadays a considerable position in rural farmsteads. Hence, there must be concluded that one of the basic current tasks is the increase of the effectiveness of social influence of the law on the thermal modernization at rural areas.

Résumé

The most of country dwelling houses does not comply with the current, strict requirements on the rational energy consumption. One of the reasons of excessive heat consumption is mainly its loss through external baffles. These houses hence require a thermal modernization, i.e. improvement of the existing technical features of the building, what, first of all, will result in reduction of the needs of warming heat.

There is recommended to propagate the solutions which base on the passive utilization of solar energy as a renewable energy source.

The investigations carried out in the northern Casubia allow to state that the most popular thermoinsulating material is a StyroFoam. Simultaneously, a lot of

improprieties in realization of the thermal modernization was observed – both in brick and stone buildings as well as in wooden ones. The reason of such situation is in large measure the fact that rural investors do not take into consideration the importance of influence of the local climate conditions on precise solutions limiting the heat losses from the building and the costs of its heating. The thermal modernization operations in existing buildings are mostly carried out without design and consultation with entitled person.

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Summary

Application of architectural solutions in thermal modernization of existing buildings on rural areas. The paper discusses at the beginning the term of thermal modernization, ways of its realization and causes of implementation in dwelling houses on rural areas. Those houses mostly do not fulfill current strict requirements on rational energy consumption. The most important cause of excessive heat consumption is mainly its loss through external components. The second part of the paper characterizes the current state of buildings from the point of view of improvement of thermal properties of building baffles on an example of the Author's researches realized in a chosen region of the northern Casubia.

Streszczenie

Zastosowanie rozwiązań architektonicznych przy termomodernizacji istniejącej zabudowy na terenach wiejskich. W artykule omówiono na wstępie pojęcie termomodernizacji, sposoby jej realizacji oraz powody wdrażania w domach mieszkalnych na wsi, które w większości nie spełniają obecnych zaostrzonych wymogów w zakresie racjonalnego zużycia energii. Najważniejszą przyczyną nadmiernego zużycia ciepła są przede wszystkim jego straty przez komponenty zewnętrzne. Następnie scharakteryzowano stan obecny budynków pod kątem poprawiania właściwości termicznych przegród budowlanych na przykładzie własnych badań na wybranym terenie północnych Kaszub.

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