Conservation Compatible Insulation on a Baroque Building

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ABSTRACT

The application of a conservation compatible adapted thermal insulation composite system for the building envelope of the baroque "Beamtenhaus" in Marienthal Abbey in Eastern Saxony was one of the energy efficient measures applied to this building. Due to some site constraints, an innovative composition was found fulfilling the need for insulation. The surface of the plaster maintains its original appearance. Moreover the remaining original historic surface parts existing on the façade are sheltered by the system.

Keywords

energy efficiency, historic plaster, insulation composition system, conservation compatibility

1. Introduction

Within the life time cycle of a building, certain measures are applied due to added extensions of the building, changes in its use or much needed repairs. Today, while applying these measures, it is worth taking a look at how to reduce the building's total energy consumption.

The entire complex of the Marienthal Monastery Abbey, including the Beamtenhaus, is registered as cultural heritage, therefore, the building is exempt from the Energy Savings Ordinance [EnEV 2009, §24], giving scope for a variety of solutions. Naturally, basic heat protection has to be secured to ensure low demand for heating. A basic system would, in fact, improve the thermal comfort of the building and avoid unnecessary damages to the structure.

In general, there are several energy efficiency measures that could be used for the retrofit of a building. The decision of which of those measures should be applied to a building is based on the estimation of their suitability. In the case of historical/listed buildings, it is crucial to check that the method of choice be compatible with its preservation. It is, therefore, essential that the team include heritage experts and that these be included in both the planning process and the works to maximize energy efficiency.

Among the national and European policies to reduce energy use and carbon dioxide emissions, there are specifically targeted energy requirements for buildings, whether new or existing, residential or non-residential, where as heritage buildings are placed in a different category and, in some cases, totally excluded.

Upgrading the thermal efficiency of an existing building can be very challenging, particularly where the building was built using traditional materials and construction methods that are of architectural or historical value.

The following is a case study of how a conservation compatible external insulation composition system was applied to a residential building with early baroque parts.

2. Initial and boundary conditions

2.1 Local situation

The Marienthal Abbey is located in eastern Saxony, about 20 km south of Görlitz, on the border with Poland. Founded in 1234, the monastery is the oldest Cistercian nunnery in Germany. Today15 nuns live in the convent. During the monastery's long history, several buildings were erected on the hilly grounds next to the river Neisse that forms the border with Poland. This complex includes more than 20 buildings in a loose building development. The Beamtenhaus stands in an outer but important position right at the entrance of the abbey. It is the building that first welcomes visitors and guests.

The Beamtenhaus itself is a long, two storey building. Only the tilted south side has a cellar. The building is covered with a cold half hipped roof.

All information on the building's history is contained in the internal report of Nimoth [1]. Very little information about the building's recent history has been recorded, therefore little is known about what was originally built on the same spot of land. First written documents including photos and postcards record the former state since the end of the 19th century. The Beamtenhaus is a construction of several phases and was often changed in the course of time. The oldest parts, most probably of early baroque age, are to be found in the upper parts of the north-western gable.

In the 1980s an extensive restoration of the roof and parts of the SE- and SW-facades was carried out. The NW-facade, facing the hilly side, was laid open in 2007 to 2008. The masonry prior in contact with the soil was uncoupled and a new wall in small distance overtook the earth pressure.

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Figure 1 Front facade of the Beamtenhaus in Kloster St. Marienthal, before changes (07/2010) and after (05/2011).

Figure 2 Location of the Abbey St. Marienthal in Germany

Some of the existing baroque windows received new colour not in accordance to the findings. Despite the overall massive construction changes on the building. the confirmation of the original structure of the facade in the roofing part and still existing evidences on architectural structures, plaster and original colour could be found in extensive investigations. Parts of an original roof framework in the northern part was dated to 1683 by dendrochronological determination.

The later constructed and changed roof, which we see today can be dated to about 1731. This is in agreement with the dating of the oldest decorated final renderings about 1700. A second baroque changing phase is assumed from 1730 to 1750. Not until the 19th century did the next major renovation and redesign of the facade of the Beamtenhaus take place.

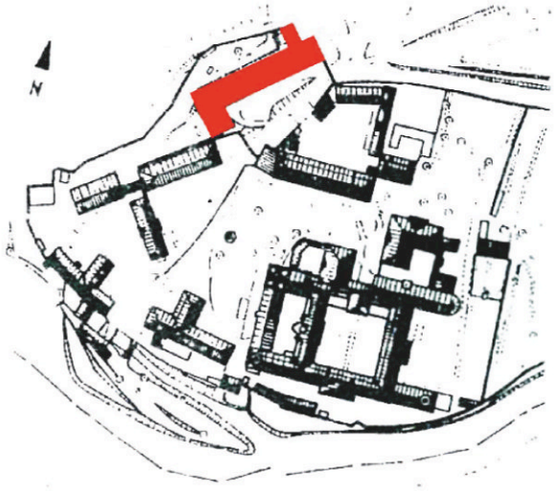

Figure 3 Position of the elongated Beamtenhaus (red) in the monastery building assembly of Marienthal (source: adapted from [2]).

The last major changes with respect to the building construction were after 1945 with the conversion to residential dwellings. In the 1980s restoration of the roof and parts of the facades was carried out. All information on the building is collected in a Raumbuch, but energy information, as suggested in [3] is not included yet. Since 1993 the building has been occupied by the International Meeting Centre of St. Marienthal (Internationales Begegnungszentrum, IBZ).

In 2010 and 2011 the facades of "Beamtenhaus" in Marienthal Abbey were retrofitted and in parts with respect to optimal energetic efficiency [4].

2.2 Preliminary investigations

Especially the NW-facade presented a challenging situation in terms of climate and moisture. Although direct contact with the soil of the hill was interrupted by works in 2007 and 2008, the facade suffers from a cold and moist situation. Due to the north orientation the surface never receives sunlight.

The ground level is rising, all the situation in that part is in the shade and air movement is low. Even though the water deduction is good the conditions are steadily moist and assumed to shift seldom to drying conditions (Figure 4a, b).

Figure 4a, b A trench at the north facade functions as interspace to the soil.

The masonry of the northern facade has a quite heterogeneous composition. In the brick masonry local granite and other stone cobbles, different kinds of bricks and other irregular pieces are found including wooden parts (Figure 5). The surface of the facade is uneven with undulations of a decimeter. Different joint mortars are present but some joints have been lost leaving gaps of several centimeters in depth. In some areas parts of the original baroque plaster was located on the facade. The distribution was mapped. Mortar analysis shows that the mortar is low in binder content, has clay parts and is of a brownish colour. Nowadays the single layered plaster looks identical to the joint mortar. It is lime with white matrix and lime lumps (Kalkspatzenmörtel).

Figure 5 Heterogeneous masonry, missing joints

The aggregates show a fairly staged grain size distribution. In contrast to some of the younger mortars, no dolomite content was detected. Many of those mortar surfaces were encrusted in a black (gypsum) layer. Often loose parts and voids in the plaster and many other damaged features were observed.

The moisture and salt load of the wall was inspected by profiles of drill powder. Two lateral profiles with samples from different heights and depths were sampled. The salt analysis did partially show high salt loads. The salts were mainly sulphates and nitrates.

Due to the partial damp situation, which could not be eliminatedor changed, all insulations which are sensitive to frequent moisture had to be excluded. The study and description of the original mortar helped find a conservation compatible surface plaster layer.

2.3 Building Physics - Modeling

Added to the investigations on the structure of the building was the inspection of the building's physics including building climate and other energy related tasks. The prior needs on energy for heating and primary energy were determined and evaluated. The reduction of heating due to the application of insulation on the northern facade was calculated. Possible damage risks were detected and recommendations deduced from specific computer modeling.

The inspection concerning energy efficiency reassured that due to the monument status of the building, the requirements for exception from Energy Saving Ordinance were fulfilled [EnEV 2009, §24]. - The Beamtenhaus receives its heating from a small district heating system of a biomass power plant. This is supplied by wood, a renewable resource. Thus the demands concerning the primary energy demand referring to heating were already met without intervening on the building. Itself. However, an improvement of the thermal insulation was considered for several reasons. Also energy from renewable resources have to be used efficiently to reduce the total energy consumption and the CO_2 emissions. The minimum heat protection has to be secured to assure a low heating demand, to improve the thermal comfort and to avoid damage. Thus energy efficiency measures serve to preserve the building. As regards the building type classification, the Beamtenhaus is considered thermally as heavy and massive. The outer mixed material walls about 0.85 m in thickness and inner walls up to 0.8 m in thickness make the building slow in terms of room climate.

Finally, all the building was inspected by the standardized procedure of the German Energy Performance Certificate "Energiepass". In those terms the historic building performance was calculated to an average energy consumption value of 92 kWh/(m²·a).

3. Approach and solution

3.1 Preserving the original substance

The parts of the original baroque plaster were fixed to the wall and held by a net (Figure 6a, b Safeguarding baroque plaster under heat insulation plastera, b). The margins were consolidated by means of silicic acid ester. Thus most of those original parts are now preserved under the insulation plaster.

Figure 6a, b Safeguarding baroque plaster under heat insulation plaster

3.2 Plastering

On the northwestern facade the plaster, which was highly loaded with salts, and the younger cement based plaster were removed. Loose joints were removed. The surface was cleaned by means of high pressure water cleaning. The historic original parts of plaster were treated separately, secured and consolidated in the outer zones. Cracks in the wall were injected.

Figure 7 Northwestern façade of the Beamtenhaus

All the façade was plastered with an insulation plaster. On average this has a thickness of about 6 cm. The plaster follows the undulated original surface behaviour of the wall. This was covered with a fine lime plaster, following in sieve line and appearance the historical one. In the pedestal zone, the underlying render is a waterproof one. All the composite system is finished in a colour which is traditional in all the monstery.

The insulation plaster improves the insulation of the heterogeneous wall significantly by about 33%. Some of the modern building standards in terms of numbers are not yet reached. The risks of consequential damages and losses are kept to a minimum. The historical appearance of the building is preserved. In the areas newly treated by IRT, the underlying historical structure [5] is no longer detectable (Figure 8 Dull temperature distribution on thermal insulation composite system of the Beamtenhaus).

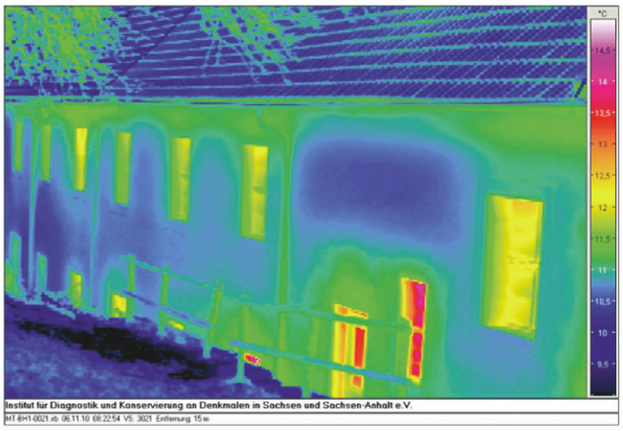

Figure 8 Dull temperature distribution on thermal insulation composite system of the Beamtenhaus

3.3 Conclusive remarks

The main objective of the restoration works was the unchanged preservation of the historical stock and its appearance as far as possible. The Beamtenhaus exhibits a quite heterogeneous constitution developed over time. A complete knowledge of the stock as well as of the structure, with respect to building physics was essential for the planning. The preexisting state of the Beamtenhaus, the measurements and the state after the measurements were documented under preservation standards.

The aim of the energetic retrofit should not be based solely on specified guidelines such as the standardized Energy Performance Certificate, but has to refer to the practical use and the behavior of the user in the specified object.

The Beamtenhaus needed individual solutions in several situations instead of standard formulations. This required all parties involved to make minor adjustments in their planning efforts, an improved quality assurance and intensified communication with and between experts, owner, investor and monument preservation until the termination of the works. Necessary amendments in the course of energetic improvements have to adapt to the existing materials, which in this case was the historical plastering and the outer appearance.

4. Acknowledgements

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