IVIS2017
13th International Vacuum Insulation Symposium - September 20–21, 2017, CSTB, FRANCE

Using SIMs to re-create cultural historical values in buildings from before 1945

P. Johansson[a,*], P. Wahlgren[a]

[a] Department of Architecture and Civil Engineering, Chalmers University of Technology, 412 96 Gothenburg, Sweden

* Corresponding author, Tel. +46 (0)31-772 19 66, email par.johansson@chalmers.se, paula.wahlgren@chalmers.se

Abstract:
In Sweden, approximately 25% of the energy use in buildings is attributed to buildings from before 1945. In this study, in-depth inventories were made in 94 buildings of cultural historical values (ornamentation, original materials and paint, etc.) and the interior status of the building (cracks, moisture damage, additional insulation, etc.). The inventories were used to investigate alternative and improved solutions for re-renovation to re-create e.g. architectural details and cultural historical values using novel materials. Two case studies are investigated where super insulation materials can be an alternative during renovation.

Keywords:
Listed buildings, renovation, VIPs, thermal bridges, energy efficiency

1. Introduction

In order to achieve the national and European environmental objectives, it is necessary to increase the energy efficiency of the old building stock. A complicating factor when it comes to the older buildings is that many of them are historically valuable. They are therefore protected and only small changes can be made when retrofitting these buildings. In addition, building owners realize the advantage of keeping or restoring old buildings since they are considered more attractive. By using super insulation materials (SIMs), such as vacuum insulation panels (VIPs), the thickness of the wall can be kept at a minimum and thereby increase the possibilities to preserve the aesthetics of the building. Previous studies [1, 2] have shown that the energy use can be reduced by 20-30 % in a building by adding a layer of VIPs in the exterior wall.

In this paper, an overview of 94 buildings in central Gothenburg is presented. Two case studies where SIMs can be used during renovation are then presented. Both buildings are situated in Gothenburg, southwest Sweden, near the coast. The first study (Brämaregatan) investigates the potential energy savings after renovating a building from 1910. The second study (Malörten) concerns a building from 1930 where VIPs were installed in 2010. Measurements of temperature and relative humidity are still ongoing.

2. Inventories of cultural and historical values

To get an estimate of how many buildings that are in need of renovation and can benefit from SIMs, an existing inventory and status assessment was used. The inventory was performed by Trafikverket (Swedish transport administration) and included site visits and interviews. In Fig. 1, the results for 94 buildings, from before 1945, are shown.

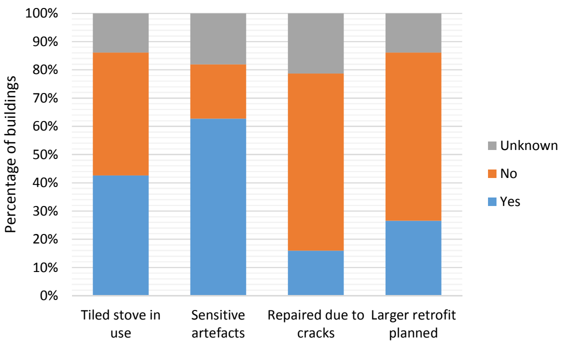

Fig 1: Information on the 94 buildings in the inventories presented in [3] and by Trafikverket.

The sensitive and vulnerable artefacts can be stoves, stucco, paintings, tiles and sculptures in the building. Larger retrofit was planned for 25 of the buildings. There is large potential for using SIMs for renovation.

3. Case study Brämaregatan- Energy use

Brämaregatan 1, see Fig. 2, is a building from 1910 that has been renovated twice; in 1975 and in 2010.

Fig 2: The building at Brämaregatan in its current state, after 2010.

The building at Brämaregatan has a brick ground floor wall, two floors with wooden walls and an attic floor (habited). At Brämaregatan, the possibility to use VIPs or aerogel blankets is investigated along with other energy efficiency measures, see Table 1. Alternative 1 for windows is to change single-pane windows on the ground floor (U=5.5 W/m²K) and alternative 2 is to change all windows (also double-pane with U=2,5 W/m²K) The building and the investigation is described in more detail in [4].

Table 1: Alternatives for insulation of exterior walls.

Brick wall: a. Add interior insulation with R = 1.35 m²K/W b. Add exterior insulation with R = 2.70 m²K/W
Wooden wall: Add exterior insulation with R= 5.41 m²K/W

Fig. 3 shows the effect of all measures on the total energy use (including tap water but excluding domestic electricity) and space heating demand.

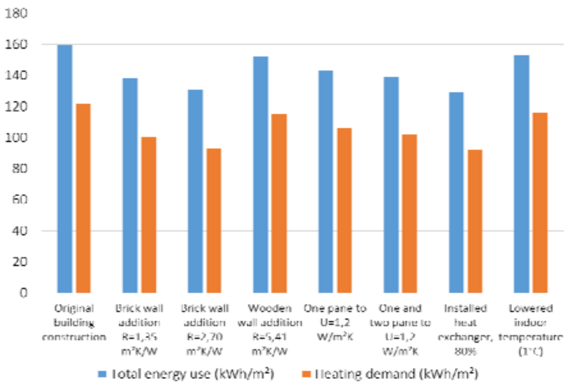

Fig 3: Total energy use and heating demand for different measures, yearly values per m² floor area [4].

If the best measures to decrease transmission losses are used, the total energy use can be lowered to 108 kWh/m² and heating demand to 70 kWh/m². If heat exchanger and decreased indoor temperature is included, the total energy use can be lowered to 67 kWh/m² and heating demand to 30 kWh/m².

4. Case study Malörten- Long term performance

A 1930s building, Malörten, has been insulated with 20 mm VIPs on the exterior. Temperature and relative humidity sensors monitor the wall and the interior and exterior climate. The wall was finished in August 2010. Comparing the reference wall with the retrofitted wall gives an approximation of how much the thermal resistance of the wall has been improved. For this analysis the average temperature for January each year 2011 to 2017 was used to calculate the temperature factor, see Fig. 4. Unfortunately several sensors have been damaged why only one position can be evaluated for all 7 years.

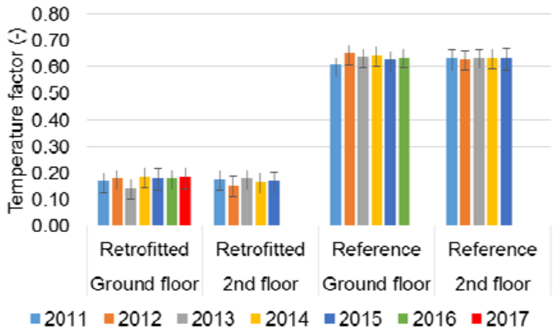

Fig 4: The temperature factor of January 2011 to 2017 for the retrofitted and reference walls. The temperature factor is the percentage temperature decrease over the original wall compared to the total temperature drop over the wall. The error bars show an accuracy of the sensor of ±0.5 °C.

In the reference wall about 64% of the temperature drop was over the uninsulated parts. After the retrofitting only about 17-18% of the temperature drop was over that part of the wall. There is no sign of decreased insulation performance of the VIPs.

5. Results, Conclusions and Outlook

There is a large need in Sweden to renovate older buildings and maintain the cultural and historical values. SIMs can contribute to this development. This will be further investigated in additional case studies in Gothenburg. At Qvidingsgatan, several similar buildings will be investigated. They have been renovated in different time periods and with different measures. One building will soon be re-renovated. The renovated buildings will be evaluated and new methods proposed. At Kvarnbyn, a large industrial area will be converted into a residential area and VIPs will be tested in field and evaluated during and after renovation.

Acknowledgements

The work has been financed by the Swedish Energy Agency projects 40461-1 and 42856-1.

References

[1] P. Johansson, et al., Energy and Buildings, 73 (2014) 92-104.
[2] P. Johansson, et al., Building and Environment, 79 (2014) 31-45.
[3] P. Johansson, et al., Recreation of cultural historical values in buildings from before 1945: Inventory with focus on building physics performance, Proceedings of XIV DBMC, 14th International Conference on Building Materials and Components, Ghent, Belgium, 29-31 May, 2017.
[4] G. Thuresson, Energy use in a re-renovated building from 1910, Master's Thesis BOMX02-17-69, Chalmers University of Technology, Department of Civil and Environmental Engineering, 2017.