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Experiences from Interior Super Insulation of a Brick Wall from the 1800s

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1 Introduction

There are several challenges associated with decreasing the energy use in existing buildings, especially in buildings of national interest for cultural heritage or listed buildings. Generally, walls can be insulated either on the interior or exterior side. It is well known that interior insulation decreases the drying-out of the wall and increases the risk for freeze-thaw damages in brick walls (Johansson *et al.*, 2014). Interior insulation will also negatively affect the thermal storage capacity of the building and change the interior appearance of the walls, which is important to consider for historical and/or listed buildings (Johansson *et al.*, 2019).

In this paper, a study of using super insulation materials in retrofitting of exterior walls is presented. Various parameters influencing the heat flux through the wall is discussed based on calculations and measurements from different parts of the year. The aim of the project is to propose practical guidelines and recommendations for using super insulation materials in listed buildings. This research is based on evaluation of vacuum insulation panels (VIP) and aerogel blankets (AB), see Figure 1, in a field study building in Gothenburg, Sweden.

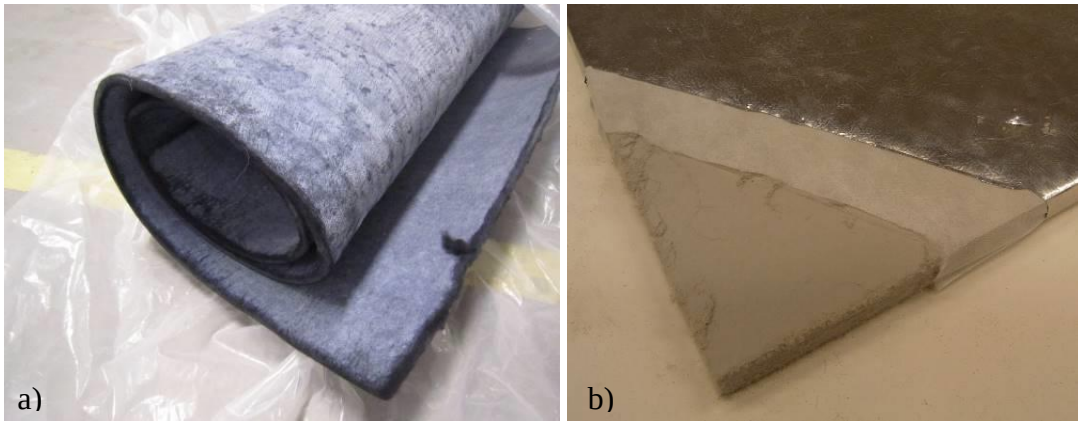

Figure 1. Super insulation materials; (a) aerogel blanket (AB), (b) vacuum insulation panel (VIP).

In the IEA Annex 65 'Long-Term Performance of Super-Insulating Materials in Building Components & Systems' several super insulation materials were investigated, and case studies were collected (Adl-Zarrabi *et al.*, 2020). VIP are rigid panels which cannot be cut on site and are sensitive to puncturing. Therefore, attention must be paid in the design of details and envelope components. AB are more like conventional fibre-based insulation materials. They can be cut at the construction site and adapted to the specific measurements.

The building where the tests are carried out is a long narrow brick and concrete building once used as a paper machine hall, originally erected in 1896. Inside a part of the building, a small room (2.1 x 2.6 x 4.0 m) was constructed. The exterior wall is divided in three parts where AB and VIP are installed in 500 x 1,200 mm^2 panels and compared to a non-insulated reference. The room is heated to around 23°C. The temperature and relative humidity are measured.

2 Results from Heat Flux Measurements

Each wall set-up (reference, AB, VIP) has two heat flux sensors, bottom and top and the heat flux was measured at three occasions (March, April and November) at all six locations. The momentary U-value and percentage difference compared to the reference wall based on the measurements and calculations are presented in Table 1.

Table 1. U-value and percentage difference compared to the reference wall based on heat flux measurements in the brick wall in the bottom and top of the wall. The average outdoor temperature was 5.1°C, 9,7°C and 4.5°C.

Location	March		April		November	
Aerogel bottom	0.310	77-84%	0.296	81-84%	0.357	70-72%
Aerogel top	0.292	78-85%	0.264	83-85%	0.339	71-73%
VIP bottom	0.308	77-84%	0.254	84-86%	0.341	71-73%
VIP top	0.323	74-84%	0.277	82-85%	0.358	70-72%
Reference bottom/top	1.331/1.957		1.549/1.817		1.188/1.269	

3 Conclusions

In a case study building, interior insulation was proposed as a measure for combining energy efficiency and heritage preservation. Measurements of the heat flux show that additional superinsulation substantially decreases the U-value of the wall. Assuming wet bricks, the average calculated U-value was reduced by 70% for the AB and 81% for the VIP layers, while the measurements at the three occasions gave a reduction of 72-83% for the AB and 72-84% for the VIP layers, i.e. the same order of magnitude. The aim is to contribute to the development of recommendations on how SIMs can be used in historic buildings

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