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Practical Applications of SIMs: Retrofitting at the Building Scale

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Abstract:
In this extended abstract and poster, conclusions from the IEA EBC Annex 65 Subtask 3 on Field scale performance of SIMs are presented. Full scale experiments provide knowledge of practical and technical difficulties as well as data for service life estimations of super insulation materials (SIM). For certain conclusions to be drawn from existing case studies, long-term monitoring is essential. Unfortunately, monitoring is only performed in few case studies. In total 10 case studies using advanced porous materials (APM) and 22 using vacuum insulation panels (VIP), spread over 12 countries on 3 continents, have been scrutinized. Four main remaining challenges were identified and the status of these are discussed in the report based on discussions throughout IEA EBC Annex 65. The long-term performance (25-100 years) cannot be entirely determined due to lack of data for longer time period exceeding 15 years. However, there were few claims concerning the malfunction of SIMs in construction.

Keywords:
super insulation materials, case studies, long-term performance, thermal bridges, energy efficiency

1. Introduction

To accelerate the introduction of SIMs on the construction market there are some challenges that must be overcome. The first challenge is the cost versus performance ratio. The thermal performance of SIMs is practically two to five times better than conventional materials while the price is generally between 4-15 times higher. The second challenge is the long-term performance of SIMs. The service life of a building is 25-100 years while the SIMs for building applications have been developed in the recent decades. The third challenge is that the construction market is a conservative market, regulated by numerous codes and standards, and thus, introducing new products takes a long time. The fourth challenge is knowledge and awareness among designers concerning using SIM. For instance, due to their nature, VIPs can't be adapted in size on-site by e.g. cutting. This may require additional effort during the design stage of the building process.

In this extended abstract and poster, conclusions from the IEA EBC Annex 65 Subtask 3 on Field scale performance of SIMs are presented. The objective of the task was to define the application areas of SIMs and to describe the conditions of the intended use of the products. SIMs can be divided in advanced porous materials (AMPs) and vacuum insulation panels (VIPs) which have different requirements on the design and construction.

2. Case studies in the field

The long term performance of SIMs has to be determined based on case studies in field and laboratory. Full scale experiments provide knowledge of practical and technical difficulties as well as data for service life estimation. The case studies are distributed in 12 countries on 3 continents with various climate conditions and building traditions, see Fig.1. For certain conclusions to be drawn from the case studies, monitoring is essential. Unfortunately, monitoring and follow up is only performed in few of the case studies.

Fig 1: In IEA EBC Annex 65, 32 case studies in 12 countries on 3 continents have been scrutinized.

Among the conclusions regarding APMs is that they have been successfully installed since the early 2000s in case studies and assemblies. Knowledge of the hygrothermal properties are important to predict the performance at the material, component and building scale. The aerogel-based products, such as blankets, are in general vapor permeable and hydrophobic. In one of the reports on applying aerogel-based blankets as insulation in an old building [1], IR thermography was used to quantify the temperature difference on the exterior surfaces of two buildings, see Fig. 2. The investigation showed no degradation of the insulation performance.

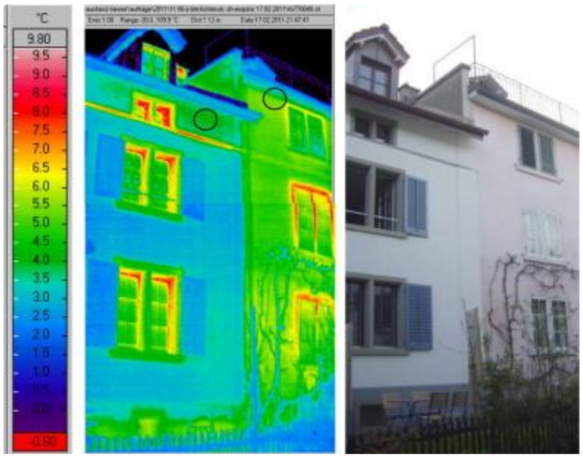

Fig 2: Infrared and conventional picture of the southern façade taken on February the 17th 2011 [1].

Previous IEA Annex 39 investigated the possibilities to use VIP in buildings during 2002-2005 [2]. In total 20 constructions were analyzed in respect of the consequences on energy use, thermal bridges and moisture performance. In this Annex, 22 more recent case study buildings were investigated. Four of them have long-term monitoring. One example is presented in Fig. 3 which is a masonry wall of a commercial building that was retrofitted on the exterior with VIPs (glass fiber based core) [3]. VIPs were sandwiched between two layers of XPS. The instrumented VIP wall was constructed in 2009. Recorded sensor data and thermographic images till to date (January 2017) show no significant aging or failure of VIPs.

Pre-Retrofit Post-Retrofit

Fig. 3 Infrared image of the retrofitted wall clearly indicating the reduced impact of thermal bridges [3].

3. Remaining challenges for SIMs

During the work of the IEA EBC Annex 65 several questions regarding the long-term performance of SIMs and their application on the building scale have been identified and discussed. Four main remaining challenges were identified and the status of these are discussed below.

3.1 Knowledge and awareness among designers concerning using SIM

Special care is necessary during installation compared to conventional insulation materials, since the VIPs are sensitivity to mechanical puncturing of the envelope. Therefore, there may be a need for certification of craftsmen and need of special training.

3.2 Conservative construction market

The building industry is generally conservative to new solutions and materials. The industry is regulated by numerous codes and standards, and thus, introducing new material takes a long time. The ongoing standardization on the material and product levels may trigger building components with SIMs integrated to be introduced on the market.

3.3 Cost versus performance

There are valuable savings of space when less area is needed for the building elements which leads to an increased rental income. There can also be technical reasons to select a SIM, i.e. when conventional insulation materials are not a practical alternative or for architectural reasons.

3.4 Long-term performance of SIMs

Theoretical considerations and first practical tests showed that VIP, especially those with fumed silica core, are expected to fulfil the requirements on durability in building applications for more than 50 years. Both VIPs and APMs have been successfully installed over the past 15 years in buildings. However, real experience from practical applications exceeding 15 years for VIPs is still lacking.

4 Conclusions and outlook

The long-term performance (25-100 years) cannot be entirely determined due to lack of data for longer time period exceeding 15 years. However, as seen above and more thoroughly discussed in the report of IEA EBC Annex 65 Subtask 3, there were few claims concerning the malfunction of SIMs in construction.

Acknowledgements

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