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POSTER ABSTRACT

Reversible internal wall insulation for historic buildings using cyclododecane as a protective layer

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When refurbishing historic or listed buildings, it is necessary to find insulation solutions that do not disrupt the original appearance of the building. This is especially true in historic buildings, where the original materials, surfaces and structures may form part of the public displays. Internal wall insulation leaves these aspects visible, but can be difficult to mount without damage to original interior surfaces and plasters. In the case of historically valuable buildings this can lead to restrictions in retrofitting energy saving measures like internal wall insulation. Refurbishments in old and valuable buildings should therefore be carried out without, or with only minimal, damage to original interior surfaces and plasters.

This poster describes the development of a new reversible mounting system using cyclododecane (CDD), a volatile binding medium. CDD allows the application of different internal wall insulation systems without damage to the underlying wall. A preliminary study using an adhesive mat as a separating layer proved promising, but allowed mould growth because of air flow (Bichlmair *et al.* 2014). To avoid this problem, a fully-reversible system was designed, using CDD in combination with a newly-developed plaster. A case study in the 18th-century Alte Schäfflerei building, now the Fraunhofer Centre for Conservation and Energy Performance of Historic Buildings (`www.denkmalpflege.fraunhofer.de`), tested the suitability of this system in a historic building (Figure 1). The case study aimed to get information on the long-term behaviour of the mounting system in practical use, and to measure the impact on original surfaces of the internal wall insulation system and mounting/removal procedures.

Ten different internal wall insulation systems were tested on prepared test fields containing

Figure 1 The Alte Schäfflerei building at the Fraunhofer Centre. Different internal wall insulation systems using CDD as a separating layer are being tested in the upper floor. Photo: Fraunhofer IBP.

matrices painted with original colour binder systems. Each test field was about 10 m^2 in size and included a window with window seals and reveals (Figures 2 and 3). Measurements of temperature and RH, and metrical and visual comparative assessments were made on these test fields in order to find out the long-term effect of the insulation systems on the underlying historic lime plaster.

With the help of CDD as a volatile binding medium it is possible to fix internal wall insulation systems without damage to the original wall. Figure 4 shows a typical system made from aerogel plaster as internal wall insulation (2), a reversible plaster layer (3) and CDD (4) as a protective separation layer from the 'original' paint layer (5).

The sublimation rate of the CDD through gypsum board was measured at a nearly constant 2.1 g/m^2/day. The measurements show that the diffusion coefficient is strongly dependent on the density of the applied CDD, whereas the density is dependent on the type of application (e.g. on how the melted CDD was sprayed or cast). Since

Figure 2 An overview of the room, containing a test field that has had the complete insulation system applied (central area, between the cable trunking, and including the window). To either side of the test field, the original historic wall surface is visible. Photo: Fraunhofer IBP.

the number of test probes was very small, further measurements should be performed to verify this data.

This research demonstrates that it is possible to design a reversible interior insulation system using CDD as a protective layer for original surfaces on historic buildings.

Biographies

Stefan Bichlmair studied Wood Technology at the University of Applied Sciences Rosenheim, followed by ten years of experience as an engineer at a building manufacturer producing pre-fabricated wood-frame walls. After gaining a Masters degree in wood technology, he made a scientific examination of the impact of indoor climates in the Linderhof Castle at the Fraunhofer IBP. Since 2010, he has worked at the Fraunhofer IBP. His main research interests are internal wall insulation for old and historic buildings, Temperierung heating systems and concepts for building climatisation, as well as assessments of indoor climate in castles, churches and museums.

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Martin Krus has worked for the Fraunhofer Institute for Building Physics since 1985. He is Head of the 'Moisture Management' group within the department of Hygrothermics, and Head of the 'Moisture, Mortars, Radiation, Emissions' Testing Laboratory. He is an Honorary Professor at the University of Stuttgart and an Adjunct Professor of Building Physics at the University of Applied Sciences, Rosenheim. His main research areas are damage assessment by hygrothermal calculations, field and laboratory tests, as well as the development and assessment of strategies to prevent mould growth within buildings and microbial growth on facades.

Ralf Kilian studied Civil Engineering and Restoration, Technology of Arts and Conservation Science at the Technische Universität München. Since 2005 he has worked at the Fraunhofer Institute for Building Physics, Holzkirchen, where he is responsible for cultural heritage research. His work deals with aspects of monument preservation and energy efficiency, with sustainability in retrofitting museums, as well as with the indoor climate in historic buildings and its impact on works of art. From 2009 to 2014 he was scientific coordinator of the large-scale EU-funded project 'Climate for Culture'. Ralf Kilian is an active Member of CEN TC 346 'Conservation of cultural property' and of the WTA.

References

Bichlmair, S., Krus, M. and Kilian, R. (2014), 'Testing a new method for VIP interior insulation for heritage buildings', in J. Arfvidsson, L.E. Harderup, A. Kumlin and B. Rosencrantz, eds, *10th Nordic Symposium on Building Physics*, Lund University, pp. 1349–1356.

Figure 3 A test matrix with different colour binding systems. The test squares have been sprayed with CDD and are already partially covered with the reversible plaster layer. Photo: Fraunhofer IBP.

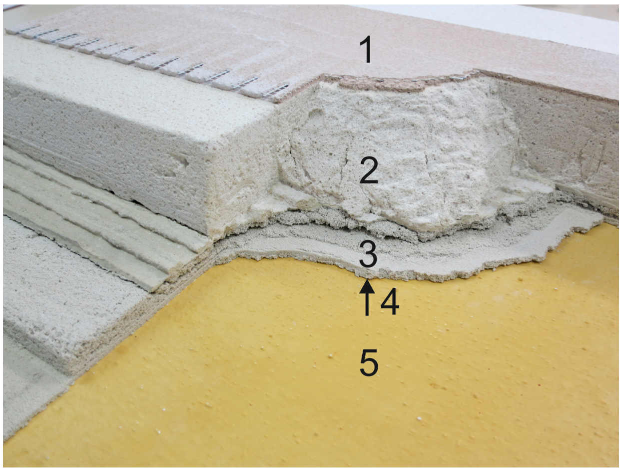

Figure 4 Example of an internal wall insulation system with each layer exposed. In order, these layers are: 1) plaster; 2) internal wall insulation; 3) reversible plaster; 4) CDD (not visible); 5) 'original' paint layer (in this case, a mock-up using typical historic pigments and binders). Photo: Fraunhofer IBP.