Reducing carbon dioxide emissions with vacuum insulation panels (VIP): Investigation of the durability of VIPs with bonded top layers and in adhesive bonding use

For some years now, VIPs or vacuum insulation panels have been used to ensure or improve thermal insulation of building envelopes. Thermal conductivity of these panels is about six to ten times that of conventional insulation materials. To make sure that insulation remains efficient over the entire service life, the VIPs need to be enclosed in a tightly sealing covering to minimise any increase in gas pressure that may occur in the panel.

The national approval requirements for VIPs already include test scenarios to assess the durability of thermal conductivity. Recently, a new method of integrating these products into the building envelope has become popular, namely bonding, and the effect which adhesive bonding may have on durability over the long term remains to be covered by the approval requirements. Therefore, the briefing for this research project was to investigate the impact of different sealants/adhesives and sealing systems and other substances such as concrete ingredients and screeds on the durability of the foil covering of the VIPs. Another aspect to be assessed was the effect of thermal expansion of bonded top layers on the durability of the VIPs.

Foils, sealed seams and VIPs were exposed to loads encountered in typical building practice situations where the panels are attached to substrates by adhesive bonding:

- Contact with cured adhesives over a long period of time, simulated by storing at medium temperature for several months.
- Contact with non-cured (moist) adhesives for several weeks, to simulate low curing speed of adhesives located behind/below large-sized panels.
- Contact with alkaline moisture over several months to simulate the effect of leachings from the substrate.
- Thermal/mechanical cyclical loads of panels to simulate loads caused by thermal expansion of the substrate encountered in building practice.

For the simulation, adhesives from the groups of resin-based adhesives, mineral adhesives for construction, bituminous adhesives (solvent-based and solvent-free) as well as reactive hot-melt adhesives were selected that are typically used in construction. The effect of the loads on the specimens was evaluated by measuring the internal gas pressure and the thermal conductivity

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of the panels as well as the tensile strength perpendicular to the panel surface. The test scheme was supplemented by visual inspections and determination of gas permeation through the foil and of tensile strength of the sealed seams.
The investigations showed that the (cured) adhesive coatings do not have a significant effect on the foil covering of the VIPs.

Although it was found that moist alkaline adhesive coatings or alkaline moisture (leachings from the substrate) do not cause any damage to the foil covering it cannot be excluded that the sealed seams may deteriorate if they are exposed for a longer period of time to moist alkaline adhesives or alkaline moisture emanating from the substrate. Therefore it is advisable to avoid long term exposure of foil coverings, in particular sealed seams, to alkaline moisture.

A negative effect of temperature-related mechanical alternating loads on the foil covering could not be detected.

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