The Hygro-Thermal Improvement of a Mounting System to Fasten Roof Workmen to Flat Roofs

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Abstract

A Dutch firm manufactures a mounting system to fasten roof workmen to the roof of a flat roof building to prevent them from falling down from the roof. The system is mounted to the flat roof afterwards, i.e. after the completion of the thermal insulated roof.

Because of the mechanical strength and stiffness properties of the system, it is manufactured using (stainless) steel. The steel, however, forms a thermal bridge throughout the insulated roof due to its relatively high thermal conductivity, compared to the roof system. The effect of this thermal bridge is a lower surface temperature during wintertime at the indoor surface of the mounting system, with an increased risk on internal and surface condensation. Furthermore, the heat loss through the roof is increased by the thermal bridge effect. The thermal system has an indoor and an outdoor surface. Increasing the indoor surface leads to an increase of the indoor surface temperature and therefore to a decrease of the surface condensation risk. The heat loss, however, will increase.

That is the reason why COMSOL Multiphysics® was used to optimize this thermal system. Because the assumptions, regarding the treatment of surface heat transfer coefficients at the external and internal surface, but also within the aperture in the roof, should be proved experimentally, a thermal mock-up of the thermal system has been made. Measurements of internal and external surface temperatures and heat fluxes have been performed to compare the predicted COMSOL results with these measurements. Thermal imaging was used to compare the distribution of surface temperatures, both absolutely as relatively.

Several variants have been simulated and the results are presented dimensionless as a temperature ratio and the heat loss per mounting point through the roof. Thermal insulation of the aperture is important because of two reasons: the increase of the indoor surface temperature and the decrease of the condensation risk, also within the inner surface of the aperture. The results of the comparison of COMSOL results with the mock-up results was quite reasonable: the thermal images of infrared thermal imaging and COMSOL simulations were quite lookalike. The quantitative results of temperature ratio's and heat loss differed because of the vertically mounted roof system in the climate cabinet, while it is a horizontal roof system.