Durability of diffusion-permeable underlays below discontinuous roofing

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Summary Account

Thermally insulated pitched roofs with discontinuous roofing usually need an additional draining sheet above the insulation layer, because with extreme weather conditions or unfavourable geometric shapes of the roof, discontinuous roofing is not completely water-tight. In the past, materials used for this purpose were not only water-tight, but also impermeable to vapour. In such roof cross sections, a vapour-barrier was installed and a ventilated space was provided between the insulation surface and the draining layer, in order to avoid problems caused by condensation (water) and to allow trapped humidity to dry out.

Today there is a growing tendency to do without such a ventilated space; instead, the cavitiy is filled with thermal insulation material, which means that a thicker insulation layer can be installed without increasing the dimension of the cross section.

This is made possible by newly-developed insulation sheets, which, on the one hand, drain liquid water, but, on the other hand, can be permeated by vapour. They are called „diffusion-permeable underlays“.

Since these new sheets are placed below the discontinuous roofing, their durability is required to last for the lifespan of the building. In order to prognosticate the long-term performance of new materials, specific tests have been developed and carried out on such products.

But over the past years cases of damage have shown that some types of diffusion-permeable underlays fail to function properly even after a very short time. The Aachen Institute for the study of building damage and for applied building physics (AIBAU) has analysed a number of such building failures and has made recommendations how to develop more efficient testing methods as well as how to construct less damage-prone pitched roof cross sections.

The conclusion to be drawn from the cases of failure is that, quite obviously, the test methods applied so far do not sufficiently take into account what stresses the roof is actually exposed to.

It has often been argued that failure is not due to the characteristics ot the product but to unfavourable circumstances during construction. By contrast, the results of the study show that some underlays had become defective in spite of good conditions during installation, whereas others remained damage-free over years, although the prevailing conditions during construction had been disadvantageous. Consequently, the conditions during installation can certainly not be the main cause of failure. The report describes the procedures that should be adopted when installling underlays.

The sheets are composed of several layers of different materials (functional layers). Comparative examinations have shown that these sheets fulfil their fundction more durably and have greater mechanical strength if the composite layers are not bonded, but welded or woven together.

Because of their increased mechanical strength, these underlays will be less susceptible to perforation by impact loading which cannot be completely avoided during roofing works.

Materials which are permeable even to gaseous water molecules are better suited for the draining functional layer than diffusion-tight materials, which have to be made more vapour-permeable by lengthwise stretching, that means by producing fine cracks in the diffusion-tight layer.

In order to test the reliability of a material more accurately, it will be necessary to establish new testing principles, which must be more closely related to the actual stresses to be expected. Since laboratory tests can only partly simulate the conditons a roof will be exposed to in reality, the simulation should be complemented by open-air weathering tests. Of course the disadvantage of open-air tests is that weather conditions may vary considerably, depending on the geographical position of the location. Therefore the requirements for open-air weathering must be clearly defined beforehand so that the results of different testing institutions will become approximately comparable.

Practical experience generally shows that additional draining measures are not absolutely necessary if the geometrical shape of the roof is simple and if the location of the building is not much exposed to wind-driven rain. For areas where wind-driven rain will cause considerable pressure, and for roofs with complicated geometrical shapes and penetrations at various points, the durability of the additional draining layer is essential.

The present research study is intended as a contribution towards making diffusion-open underlays more reliable in the future.