Reliability of wooden roof structures without ventilation under the sealing or top layer

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Summary Account

Whereas compact rafter insulation without ventilation has proved to function adequately in wooden structures with diffusion-open water draining beneath the roof cladding, it has been general practice to ventilate the space between the upper side of the thermal insulation and the top layers (e.g. beneath flat roof insulation layers made of bituminous sheets) in order to avoid the risk of damage. In recent years, however, even such cross sections have been increasingly constructed without ventilation, because, under certain conditions, such an assembly of layers is permitted by some regulations, whereas others point out that there is a high risk of damage if wooden structures have no ventilation at all. Current suggestions for designing such roofs recommend to ascertain the drying-out potential, to choose wood with low moisture content, and to install moisture adaptive vapour retarders or absorbent insulation materials.

In a research project supported by the Federal Office for Building and Regional Planning (“Bundesamt für Bauwesen und Raumordnung – Initiative Zukunft Bau”) the Aachen Institute (“Aachener Institut für Bauschadensforschung und angewandte Bauphysik” – AIBau) has conducted a survey among building experts and carried out inspections of typical examples of finished roofs to find out if the above-mentioned measures can make non-ventilated wooden cross sections with vapour-proof top layers more reliable, and if they will help to diminish the effects of construction humidity and of leakages when the building is in use.

1,657 officially appointed building experts asked in the survey pointed out 337 cases of damage on flat roofs. About one third of these wooden roof structures had been provided with a moisture adaptive vapour retarder. The detailed information about 28 cases concerned the development of failure, the assessment of damage and the recommended, or completed, repair works.

In general, the process of deterioration within the roof cross section had become evident because there was dripping water in the interior of the building and the surface of the roof was conspicuously uneven. After opening the cross section, the more or less extensive damage to the layers of structural

components became obvious, with the load-bearing wooden structure having been irreparably destroyed in 50% of the roofs.

Another 50% of inspected roofs showed such a great extent of damage after only a few years that a full replacement of the structure became necessary or advisable.

The results of the survey show that the damage described by experts was caused by mainly five groups of conditions: damage related to insufficient air-tightness, to leaks in the roof, to a high degree of indoor air humidity, to construction humidity (screeds, renderings/plaster, rain), or to increased moisture content of the wood.

The risk of failure could have been reduced by installing a moisture-adaptive retarder only in 4 cases out of the 28. Such retarders will diminish the risk of damage to wooden roofs with non-ventilated sealing layers only if moisture entry is limited and if, on the other hand, there is a high drying potential. The amount of moisture entry depends on the degree of leakage, the drying potential is determined by the size of the reverse diffusion current.

Non-ventilated wooden flat roofs are greatly susceptible to the effects of inadequate or defective construction and require considerably more extensive control and inspection measures. For this reason, the use of such constructions is generally inadvisable.

In spite of vapour retarders and the assessment of moisture transfer by numerical simulation the moisture content of the wood must be continuously monitored during the erection of the building. If necessary, the construction period has to be extended until wooden beams and roof boardings have sufficiently dried out. Special attention should be given to controlling air-tight layers by measuring differential pressure. Subsequent perforation of this layer should be avoided as far as possible.

If planners decide against safer alternatives such as wooden roofs with an insulation layer on top of the building component, ventilated roofs or roofs with additional thermal insulation and damp-proofing layers, and if they nevertheless want to do without ventilation of the sealing or top layer, it will be necessary to assess moisture transfer by numerical simulation and to comply with the data of the materials used. Changes to construction, such as different roof sheets, plants or superstructures on the upper layer are not permitted without assessing the hygrothermal performance of the building component.