RETROFITTING TECHNOLOGY: FOAM GLASS PERIMETER INSULATION AND CELLULOSE FIBRES FOR WALLS AND ROOF

ZEGG Ecovillage, Germany

Here, an example of retrofitting technology is presented wherein sustainable materials have been utilized to insulate an existing building; the solution has proved to be an efficient method of energy conservation. In this case, a one-storey building of 400 m² with an energy consumption of 100 kW was completely insulated from the outside. This reduced consumption to 15 kW: an 85% reduction. This will accumulate for as long as the building exists: many years of 85% energy savings compared to the uninsulated original.

Cork insulation.
Photo by Achim Ecker.

Most of the work was done by skilled, but not professional, workers. The materials used were natural recyclables, such as glass and newspaper that had been turned into foam glass and cellulose fibres respectively. Outside we used larch timber panelling, which has the extra advantage of shielding the building from all kinds of artificial radiation. This was one benefit of many to the building's users.

How it was done?

The insulated building is used as an office building at the ecovillage. Laying east to west, the southern side of the building's roof was an eyesore and inside it was freezing during the winter and like an oven in the summer. Before the improvements, its 5-cm thick walls of compressed fibreboard with air cavities held no heat, resulting in high wastage regarding winter-time heating. For these reasons, it was an obvious choice for priority insulation improvements in the ecovillage.

The first step was replacing the "Eternit" fibre cement roofing, which contained asbestos. Then 200 m² of photovoltaics were also installed on the roof: these produce 24 kW p. The roof was insulated with 25-30 cm of cellulose fibres that were blown on to the 400m² ceiling. A couple of years later, we started replacing the old windows and aluminium/steel doors with new double-glazed pine windows and doors that were treated with linseed oil, which had been produced in the local carpentry shop.

Insulation (foam glass and cellulose fibres).
Photo by Achim Ecker.

Since we did not have the money to insulate the whole building wall at once, we started work on the northern half of the building in 2007. The old façade was removed but its carrying structure left in place: the latticework support for the new insulating layers was added over this. The vertical supports (studs) were screwed directly into the old carrying structure, which also served to balance out the unevenness of the old construction without creating "cold bridges" (where construction materials that conduct heat well pierce the thermal insulation). This approach can be used anywhere the existing wall is strong enough to hold the new facade and it is unimportant if there is old plaster falling off or old paint peeling away, for example. Windows are not framed because this could also result in cold bridges. Instead, they are screwed onto the ends of the studs. The last vertical stud of the lattice is placed before reaching the corner of the

Reed insulation on green roof.
Photo by Achim Ecker.

building since the corners are where insulation is most critical and having a stud there would exacerbate the cold bridge effect. Stability is ensured by screwing the ends of the horizontal laths together where they meet at the corner.

A breathable membrane was then placed onto the wooden studs and sealed around the edges of the windows. Later, holes were cut into the membrane and celluloses fibres were blown into the cavity (18 cm wide) between the old wall and the membrane by an expert. The holes were sealed again after the insulation was inserted. The horizontal laths of the lattice were then added over the membrane and the actual façade of larch panels are screwed into these laths.

The cellulose fibre insulation, which is made of recycled newspaper, used to need 8% borate salt added to protect it from animal infestation. This was then impossible to compost after use. Fortunately, there are now borate-free, compostable cellulose fibres available.

To insulate the floor of the building, the existing concrete foundation was surrounded by a 30-cm "perimeter insulation" using compressed foam glass gravel that extended 80 cm deep into the ground. The ecological advantage of foam glass gravel is that it's a recycled product made of used glass that does not rot or chemically react with the environment. Though it takes a lot of energy to produce, it forms a capillary-breaking layer between the soil and the foundations, so no extra plastic or tar paper is needed for damp-proofing.

Work and user experiences with the construction

After planning time, the majority of the work could be done by 3 to 4 people with normal, 'layman' construction skills: only one skilled expert instructor was needed. The insulation process is quite labour intensive but relatively low in terms of the cost of construction materials.

Green insulated roof.
Photo by Achim Ecker.

The building is currently used by close to 20 office workers and as a meeting place for ZEGG's management body and others. As a result of the insulation, the working conditions of the office environment have improved drastically.

Since there are plenty of pre-existing buildings in the world, in many cases retrofitting and insulation techniques could prove to be a more efficient and thus higher priority way of reducing energy use than the construction of new, ecologically sound buildings.

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Further information
· Achim Ecker, e-mail: achim.ecker@zegg.de
· The webpages of the ZEGG Ecovillage: www.zegg.de

Other links: www.misapor.ch (foam glass gravel); www.isocell.at/en/main-menu/products.html (cellulose insulation)