

# Sandwich building elements with vacuum insulation




Sandwich building elements allow a wide variety of material combinations, and have versatile implementation possibilities in the building trade. In this research project, sandwich building elements with integrated vacuum insulation were developed. They are now being tested and scientifically evaluated in practice in a demonstration building in Neumarkt in der Oberpfalz (Germany). Construction with prefabricated facade modules and sandwich elements is one way of securely installing the sensitive high-tech plates in the building. The manufacturer can provide prefabricated elements in formats of up to 3x10 m<sup>2</sup> in size, which enable slim facades with excellent thermal insulation properties, suitable for passive houses.



Precast roof elements with vacuum-insulation during the installation at the zero-energy-house in Voggenthal (Germany). As a grey layer the vacuum insulation is to be seen.

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## Technology summary

<b>Term of project</b>	05/2003 - 05/2006
<b>Technology status</b>	 Pilot Project
<b>Key aspects</b>	Heat insulation, Facade systems

## Project description

A vacuum enables very good thermal insulation in the smallest of spaces: micro-porous silicon dioxide plates are packed into a gas-tight, water-vapour-tight sheeting under vacuum. In an evacuated state, these vacuum insulation panels have an extremely low thermal conductivity. Their insulating effect is 5 to 10 times better than that of conventional insulation systems. Thus, vacuum insulation requires a correspondingly lower thickness of insulation material to achieve the same insulating effect, which is a great advantage where there is little space, or where there are high thermal insulation requirements.

However, it has been shown that vacuum insulation panels are not particularly suitable for being handled on the construction site, as even the smallest scratch allows air to penetrate the plates, thus drastically reducing their thermal insulation properties. This risk can be kept under control much more effectively with prefabrication of finished facade elements, or sandwich elements, in industrial production conditions.

### Focus

Sandwich constructions are robust, and have versatile implementation possibilities. Roofs, walls, facades, windows and doors can be made out of sandwich elements with vacuum insulation, in large and small formats. In this project, vacuum insulation is now to be applied to the material combinations wood / wood, wood / concrete, concrete / concrete, and concrete / site-mixed concrete / concrete.

The construction principle common to all sandwich elements is a glass fibre anchor which, under tension and pressure, joins the layers at certain points, without significant thermal bridges arising.

It was intended that PUR foam strips would hold the vacuum panels firmly in place, protect their edges, and also reduce the thermal bridges at connections or joints between elements. This concept was fundamentally revised. With the new solution for anchor penetration and edge protection, the VIPs contact each other jointlessly on all sides. Thus, it has been possible to reduce the heat losses through the wall by 17%. Right throughout the demonstration building, in order to be certain to achieve the passive house standard, 40 mm-thick vacuum panels are implemented, which in turn are prepared as robust insulation plates. In some cases, the entire insulation plate is sheathed in a diffusion-tight film.

### Success

The largest VIP formats which can be manufactured are 1.25 m x 3 m, with thicknesses between 10 and 50 mm. In order to assemble a large wall surface, it is necessary to position several plates beside each other. VARIOTEC directly joins the VIP insulation elements, and forms the anchor points as a patented indentation already during manufacture. The building elements which are thus produced, can be made in all shapes and sizes, up to dimensions of 3 x 10 m<sup>2</sup>, depending on the architecture.

U-values: A 20 mm-thick element of this kind has a U-value of 0.189 W/m<sup>2</sup>K. For the zero-heating-energy

house, 40 mm-thick insulation elements were implemented, with U-values of 0.06 to 0.12 W/m<sup>2</sup>K. The maximum wall thickness was 33 cm in the cellar, and the minimum was just 15 cm in the wooden wall area. Suitability for the construction site: the large-surface sandwich elements have two-fold protection. They are sheathed in so-called ASS protective layers (solid panels of aluminium and PUR) and have diffusion-tight edging.

### **Milestones**

Demo building: the building in Neumarkt in der Oberpfalz is a residential building with an office area, and has a net floor area of 350 m<sup>2</sup>. It was built in 2004, occupied as of 2005, and should now demonstrate the application opportunities of vacuum insulation. It was constructed using a wood / concrete combination, while vacuum insulation, integrated in sandwich elements, was used in all areas. The building, situated on a problematic slope, entails strict requirements for the facade elements used, with regard to static properties and moisture protection. The total thickness of the facade is 15 to 33 cm, depending on the facade type, with a U-value which reaches 0.11 W/m<sup>2</sup>K. Prefabricated concrete elements are predominant in the areas which are in contact with, or near to, the ground. In the upper storey, wooden building elements dominate.

The prefabrication of the wall and roof elements was performed by local craft businesses. VARIOTEC provided the prefabricated Qasa insulation elements, and trained the craftspeople in how to handle the innovative insulation material. In order to enable future implementation of the building elements without laborious individual approvals, tests with regard to thermal insulation, fire protection, and construction types, are currently (2005) being conducted.

### **Application**

With the design of this building, over 50 standard details were developed, which can cover almost any construction situation. In addition, every building element can be prefabricated in a modular manner. In the building, which comprises a cellar, central, and upper storey, a total of five different roof and wall construction systems were implemented. Depending on the respective implementation purpose, these were developed as either wooden or concrete solutions, with integrated vacuum insulation elements ("Qasa").

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