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FORSCHUNGSFORUM
3/2007

Building of Tomorrow

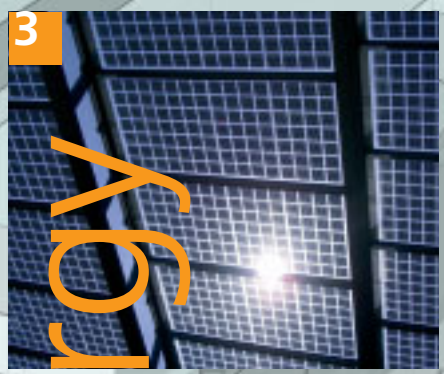
1

Window

2

Wall

3



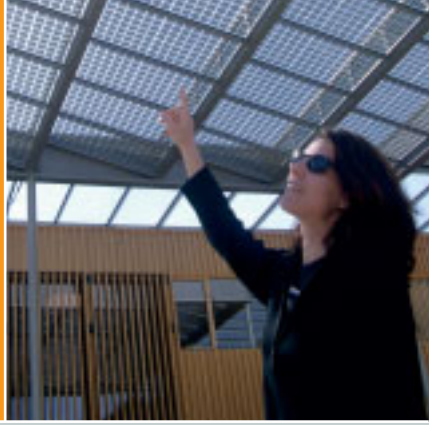
Energy

TECHNOLOGY DEVELOPMENT FOR SUSTAINABLE BUILDINGS

INNOVATIVE AUSTRIAN PRODUCTS WITHIN THE "BUILDING OF TOMORROW" SUBPROGRAM

bmvit

Austrian Federal Ministry of Transport,
Innovation and Technology



P R O J E C T S

NEW PRODUCTS FOR THE BUILDING OF TOMORROW

1 **WALCHFENSTER04**
FROM MODEL TO NEAR-SERIES PROTOTYPE
Developing the model of the walchfenster04 window and facade system to the stage of a near-series prototype including the requisite production processes and technologies

2 **NEW SUPERINSULATED LIGHT FRAME TIMBER CONSTRUCTIONS**
Development for the use in buildings meeting passive house standards

3 **PHOTOVOLTAIC MODULES FOR BUILDING INTEGRATION**
Development of new production processes for photovoltaic modules particularly suited for building integration

In 1999, the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) launched the research and technology program "Sustainable Development", which aims to effectively support approaches towards sustainability in economic activities. Various research and development projects as well as demonstration and diffusion measures, which give new impetus to innovation in Austria's economy have since been supported within the scope of a number of subprograms.

The "Building of Tomorrow" subprogram aims to develop marketable building components and concepts for residential, office and commercial buildings (new construction and renovation) and to realize them in demonstration buildings. These new sustainable developments and products should meet the following criteria as compared to still widespread building and renovation concepts:

- *Reduction of energy and materials input*
- *Widespread use of renewable energy sources*
- *Use of renewable and ecological materials*
- *Consideration of social aspects*
- *Improvement of the quality of life*
- *Costs comparable to conventional construction methods*

The Austrian Research Promotion Agency (FFG) is managing the "Building of Tomorrow" subprogram.

BUILDING of Tomorrow

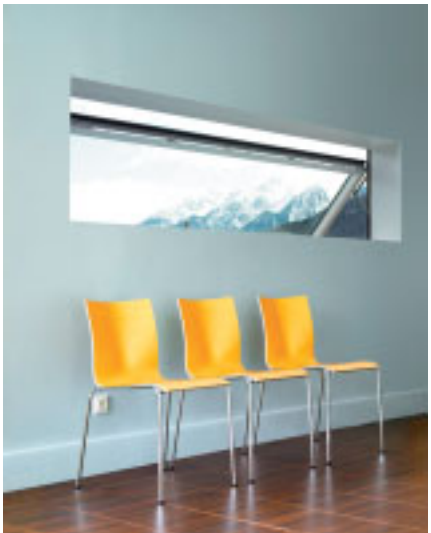
P R O J E C T 1

WALCHFENSTER04

Walch Fenster / Ludesch (Vorarlberg, Austria)

■ Walchfenster04 is a newly developed directly bonded wood-glass window system for all-glass facades. In this new design, the exterior of the wood frame is fully covered by the glass pane and thus optimally protected against weathering and environmental impacts. The large elements are particularly well suited for the use in passive houses.

While the first model served to find general technical solutions for this innovative window system, the focus of the project within the "Building of Tomorrow" subprogram was on the development of production technologies (e.g. the special wood-glass bonding technology) and process engineering as well as in the detailed elaboration of the system for near-series production.



Translating the new concept into a marketable product involved the following tasks:

- Development of all components, tools and production processes (e.g. woodworking, design of GFK-profiles, production of fittings for reversible window, production plans for various types of window, etc.)
- Development of different types of opening, manufacture of prototypes with subsequent test series (opening fatigue, maximum load tests, etc.)
- Development and test of robot-assisted bonding processes with self-designed clamping table for slender wood frames
- Development of a window heating system for extreme situations (e.g. very deep window bays)
- Estimate of production costs for industrial-scale production
- Production of near-series prototypes for testing

The new design consists of slender wood windows, which may be arranged in such a way as to form a modern glass facade. The exterior ESG (single safety glass) pane makes the window maintenance-free and easy to clean and protects the whole window system against weathering and environ- ▶

mental impacts. On account of the structural bonding of wood and glass, the windowpane also serves as reinforcing element. This facilitates the use of very slender wood frames and improves torsional stability.

Formats and sizes are designed in such a way that architectural grids of up to 2.5 m may be fitted with just one opening wing. This permits to design economical all-glass facades, and from outside it is virtually impossible to tell whether an element is a fixed or opening pane. The slender frames provide for considerably improved natural lighting. Inside, the window frames may be integrated into the (abutting) wall and thus give the impression of a frameless window.

Another special feature of the window system consists in a newly developed fitting for reversible windows, which permits to turn the window by an angle of 165 degrees and, thus, to clean the exterior of the pane from inside. Conventional fittings rotate through the sealing plane, therefore it is not possible to place the sealing at the outermost point. In this new design, the rebate holding the fitting is sealed against the outdoor air at the exterior windowpane, already.
The excellent insulation properties of the bonding material (silicone foam, psi = 0.033 W/mK) result in an essential improvement at a crucial point in the window system. This contributes to very good ratings concerning ***sound-proofing and thermal insulation***.
The technical properties of the design have been tested by several institutes (ift Rosenheim, Holzforschung Austria, HSB Biel).

At present, the system includes four types of window and facade elements: fixed window, reversible window, top-hung projecting window, and side-hung window. The standard model uses spruce for the frame; larch and oak are also available.

After two years of development, series production of the walchfenster04 began in 2007, and first projects have already been realized. The window and facade system has already received several awards for its innovative design.

Soundproofing:

The special bonding between exterior pane and the frame interrupts sound transmission within the system at the outermost point.
Thus, the window reaches soundproofing values between 34.7 and 48 dB.

Thermal insulation:

Opening pane (testing size 123 by 148 cm)
Triple thermal glazing U = 0.83 W/m²K

Fixed glazing (testing size 123 by 148 cm)
Triple thermal glazing U = 0.79 W/m²K

On account of the slender frames and, consequently the low proportion of frame surface in relation to overall window size U-values will be even better in larger formats; this advantage will be particularly important in large office buildings.

NEW SUPERINSULATED LIGHT FRAME TIMBER CONSTRUCTIONS

Weissenseer Holz-System-Bau GmbH / Weissensee (Kärnten, Austria)

The focus in this project was on development, analysis, and optimization of superinsulated wall elements for building shells using timber construction. Conception and development of the new building constructions involved the cooperation with HERAKLITH AG, ISOCELL Vertriebs GmbH, WIGOHAUS Ing. Roth GmbH as industrial project partners and the Fachhochschule Kärnten, which was in charge of the accompanying scientific program.

Within the "Building of Tomorrow" project, several different wall designs as well as various combinations of building and insulation materials have been developed, tested as well as analyzed and optimized with regard to building physics, technical implementation, and economy.

The research project aimed to analyze the mechanisms and, in particular, the long-term hygro-thermal behavior of highly energy-efficient building designs under real-life climatic conditions and to create a basis for further innovations in the field of passive house construction.

The Fachhochschule Kärnten used a new dynamic simulation program for the analysis and optimization of building designs and components as well as of details and building element junctions. This modern approach permits an almost real-life evaluation of the performance of building components at the design stage, already.

This is particularly important in timber construction as the moisture behavior of a light frame timber construction has a decisive influence on thermal insulation, durability, and long-term behavior of building components.

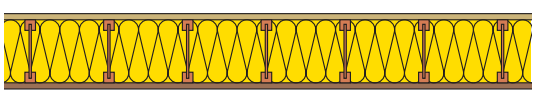
The real-life long-term behavior of the new design's building components was successfully analyzed for varying climatic conditions within the research project. In the future, it will be possible to predict the building physics-related mechanisms of components for other climatic zones as well.

In order to complement the theoretical investigations researchers erected a testing and demonstration building at Weissensee/Kärnten for the purpose of practical tests. In these tests researchers analyze individual building components and implement various measuring programs.

An important aspect from the point of view of economy refers to the high degree of prefabrication of individual components, which, in the future, will compensate additional costs that are due to the new design.

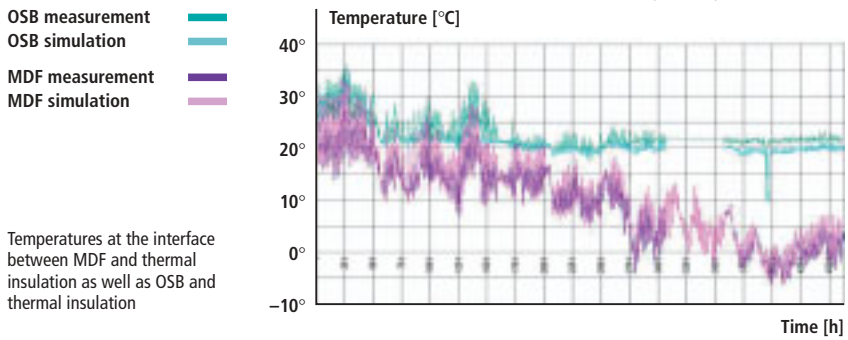
Based on the findings gained so far, the project team is currently developing further innovative building concepts. A follow-up project aimed to develop special timber constructions for the first floating passive house. Applications for this design, which globally is a novelty, include floating and amphibian houses in flood risk areas, but also waterproof basements in regular (passive) houses.

Comparison of temperature values: Simulation and measurement in the test building



Wall design

Cross-section wall (without interior and exterior sheathing): The outside consists of a high-diffusion porosity MDF (Medium Density Fiberboard), the inside of a low-diffusion OSB (Oriented Strands Board). In between there is the structural framing, which consists of thermally optimized TJI members as well as the (passive house standard) thermal insulation.



Temperatures at the interface between MDF and thermal insulation as well as OSB and thermal insulation

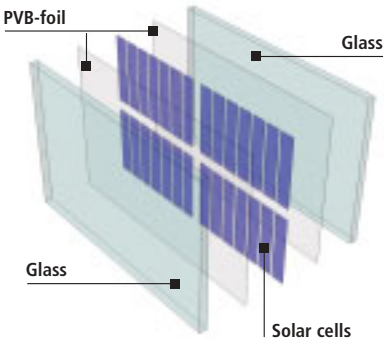
The diagram shows a comparison between the simulation at the beginning of the project and the temperature values actually measured in the test building. It clearly shows that the predicted values from the simulation come very close to reality. The simulation program is a quick and economical method to make a long-term and realistic evaluation of the behavior of building components, at the planning stage already.

Source: Weissenseer Holz-System-Bau GmbH

PHOTOVOLTAIC MODULES FOR BUILDING INTEGRATION

Ertex Solar GmbH / Amstetten (NÖ, Austria)
HEI Consulting GmbH / Vienna

Structure of a LSG (laminated safety glass) module



A large, until recently hardly used potential for sustainable energy generation in modern buildings consists in the use of the building shells as energy system. Surveys (e.g. within the IEA PVPS Task 7) have shown that the use of building facades for photovoltaic elements could cover 35 percent of the overall power consumption in Austria. This "Building of Tomorrow" project aimed to develop new production technologies for photovoltaic modules that are particularly suited for integration into the building envelope.

Building integration means that the PV modules form part of the facade or of the roof and that – apart from energy generation – they also fulfill various other functions. They are building material used for the facade and may be used as weather protection or shading system.

Concerning building integration, the PV modules currently available on the market are quite restricted by many limitations because, on account of the relatively small range of formats, small surface areas, materials and production technologies used, they do not meet the requirements of modern building and facade construction. From the perspective of many architects, a broader use of currently available PV modules for integration in the building shell, there are the following barriers:

- Inadequate technical product characteristics (formats, construction technology related properties)
- Unsatisfactory esthetics
- Disproportionate planning work
- Difficult integration in construction project management

Requirements prevailing in building integration are usually highly varied and cannot be fulfilled with conventional PV modules from mass production. A further problem consists in the lack of standardization of the modules; products from different manufacturers are not compatible and cannot be combined with each other.

At present, most PV systems use rooftop installation or are mounted on the ground. The current technological standard consists in the production of small PV modules (typical size 1.5 m^2) with an EVA (ethyl-vinyl-acetate) as laminate and a laminated plastic foil on the backside of the module.

The production process developed in the present project uses a different approach: The crystalline solar cells are encapsulated between two glass panes by means of a special bonding technology, which improves ageing stability. So far, this process has only been used in the production of laminated safety glass for buildings or by the automotive industry in the production of windshields. The new modules are not laminated with the conventional EVA foil but rather with a PVB (polyvinyl-butyral) foil. Compared to conventional production technologies, this lamination method shows advantages with a view to tear resistance, breaking elongation, residual carrying capacity, and long-term behavior.

The backside of the module does not have a laminated plastic foil, but is fitted with a second glass pane instead. This permits to produce semi-transparent modules; the design also improves ageing stability.

The use of production facilities as they are typically used in LSG ▶

Pilot project solar roof for Community Center Ludesch

The "communicative point" of the new Community Center is situated on the new village square, which has been roofed in with 350 m^2 translucent photovoltaic modules. The commune wished to canopy the village square to facilitate flexible use of the area. The roof consists of 120 high-performance PV modules, which are laid out in twelve sheets and face southwest. The roof provides for weather protection and serves as a sun shading. Apart from these functions the installation will generate some 16,000 kWh electrical energy.

production permits to produce flexible module formats and very large sizes (up to 12 m^2). The new LSG modules are break-through safe (on impacts) and are also suited for overhead constructions. After due certification by the building authorities, testing for each individual case will not be necessary.

A broad introduction of photovoltaics on the market often fails on account of the higher costs compared to other energy systems. However, in the case of facade and building integration there are substantial synergies concerning costs. The multiple use of PV modules as facade element and energy source may partly compensate for inherent higher planning costs and expenses for customized solutions. High-grade facade materials (e.g. stone) show approximately the same costs per square meter as solar facades. Integrating PV modules into the facade may result in a substantial reduction of the energy bill. Using PV modules as shading elements brings additional savings, for instance in the cooling of large office buildings.

PROJECT PARTNERS

WALCHFENSTER04
Vom Funktionsmuster zum seriennahen Prototyp
(From model to near-series prototype)
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