Zukunft Bau

STRUCTURE / SHORT REPORT

Title

Full Title: “Prefabricated window with integrated technology for refurbishments – demo project”

Overview / starting point

The installation of conventional window replacements is complicated by the involvement of numerous professional tradesmen working on multiple geometrically and structurally challenging interfaces. By integrating sun protection and building technology in a prefabricated quality element – the “window machine” – the user will profit from a less intrusive and faster construction process, lower costs, as well as higher construction quality.

Focus of the research project

The research project builds on the results of the previous research project funded by "Zukunft Bau", wherein three prototypes for renovation in buildings built between the 1950s to 1970s were developed. The previous research project focused on buildings typical of their generation in which no energy-saving improvements had yet been carried out. The main focus of this new research includes futher developing a prototype, documentation and evaluation of the construction phases, and the installation process. Requirements for the neccessary tradesmen and coordination were defined, the assembly process and the design optimized. Additionally, topics such as marketability, product design, and installation design were discussed. In the first stage, the obstacles from the point of view of 10 builders, housing contractors, trade associations, building planners, and craftsmen were discussed during an expert panel at the Munich Construction Fair in 2017. The relevant requirements of fire protection, window size, daylight, solar gains, sun protection, insect protection, thermal insulation, fastenings, window openings, ventilation, building revision, and building control were analyzed. The second stage focused on further developing the prototype, based on the project's industrial partner's pre-existing technologies. The window machine should build on the principle of the window frame: an outer component into which a composite unit of window and building technology will be integrated. The four basic components (a window frame, a sun protection system, a decentralized ventilation system and a window) were arranged in seven different combinations. The final variant, a prefabricated unit with two soffit-integrated decentralized ventilation systems, a sun protection, and a triple glazing, was constructed in detail (choice of materials, size of the basic components, assembly) into a finished product. At the same time, the building's pre-renovation temperature, relative humidity, CO2 content, heat loss during the in winter of 2016/2017 was then monitored; results were compared to simulations of the daylight and thermal physics. Dynamic daylight simulation with the Fener tool compared the daylight and solar heat recovery performance of different window samples. Simulations of the thermal physics were used to analyse two-dimensional thermal bridges in order to minimize moisture damage and to investigate the risk of humidity. In the third stage of the research project, the window machine was installed in 5 assembly steps on the demo project (preparation before assembly, installation of the partially prefabricated window element, installation of the sun protection and window, installation of the thermal isolation, dismantling the existing window and installation of the ventilation unit, interior work and plaster work). Both before and after the energy-saving renovation, during the winter of 2017/2018, the building was scientifically monitored (temperature, relative humidity, CO2 content, heat losses). The quality and function of the window machines were measured to confirm functionality. In the fourth stage, the prototypes′s development phases and the construction process were scientifically and economically evaluated. The window machine was graphically delineated in construction detail and appraised for cost parameters (with VAT). A comparison between the window machine and conventional window replacement is made clear in the economic calculation. All detailed information and the resulting evaluations of the cost planning are derived from the actual costs of the research project. In June 2018, a user survey was conducted assessing the technical building quality, the different installation phases, and the energy design performance, in order to investigate how innovative technology interacts with the user.

Conclusion

The window machine requires extensive preparation in precise building survey and in-depth planning. Once planned, however, the window machine was completely assembled in two days due to the decreased number of trademens, and installed by a single company. This saves 6% overall costs compared to conventional window replacement and reduces design defects. In accordance with the preliminary studies, the window machine shows a more efficient construction process owing to a high degree of prefabrication and integration of building technology. The window machine is tailored to the specific competencies of the industry partner (in this case, ventilation system and expanded polysterene).

Key data

Short Title: Window Machine II

Researchers / Coordinators of the project:
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Total cost: 258.469,60 €

Federal grant: 168.679,60 €

Period of the project: 24 months

FIGURES:

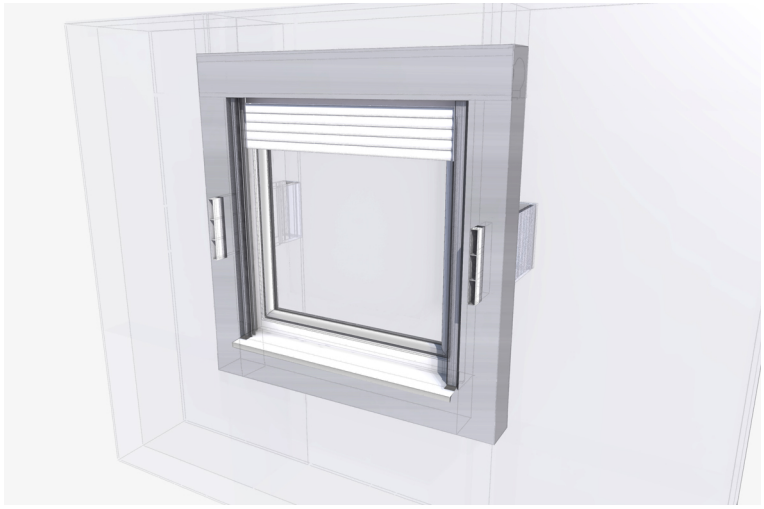

Fig 1: 3D presentation of the window machine.jpg

Fig 2: A building condition before energy-oriented renovation works.jpg

Fig 3: Preparation before installation of the window machine.jpg

Fig 4: Fixing the window machine without external thermal insulation system.jpg

Fig 5: The window machine with external thermal insulation system.jpg

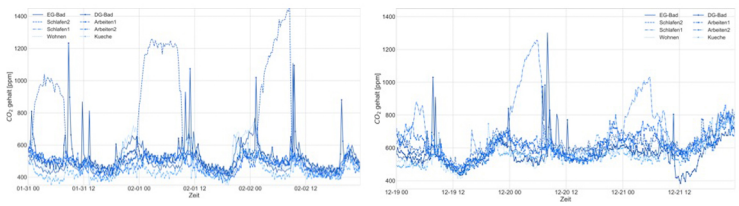

Fig 6: The CO2 diagram in a typical week before the refurbishment (left) and after the refurbishment (right).jpg

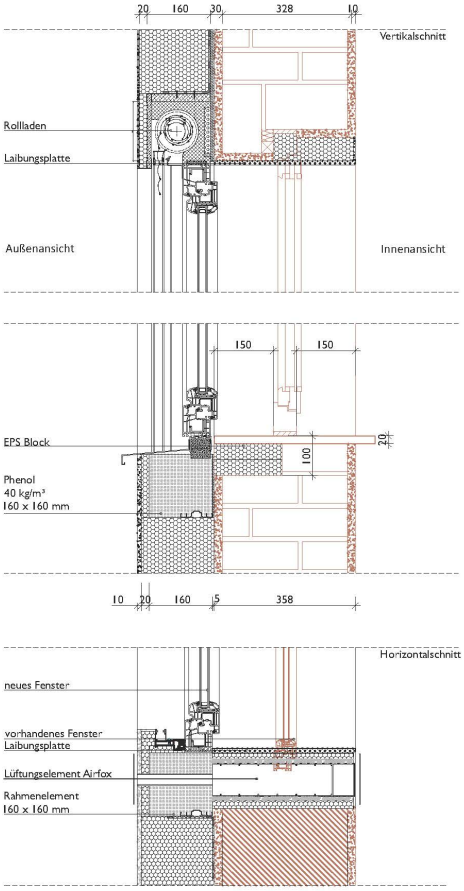

Fig 7: Construction detail of the window machine.jpg