#5396

Newly built two family house with transparent insulation in Freiburg

Dipl.Ing. E. Bollin*
Im Hubhof 8, D-7800 Freiburg 33, FRG

Abstract

A new two-family house with transparent insulation was erected in Freiburg in 1988. The design of this building follows up different approaches to reduce the energy consumption of the building, so as to balance the different solar gains through the windows and the transparently insulated walls, maximum heat insulation of the not transparently insulated parts, decentralized auxiliary heating system and integrated storage collector for domestic water heating. In this paper the design of the building will be sketched with special regard to the transparently insulated facade and the integrated storage collector. First experiences show the feasibility of transparently insulated buildings.

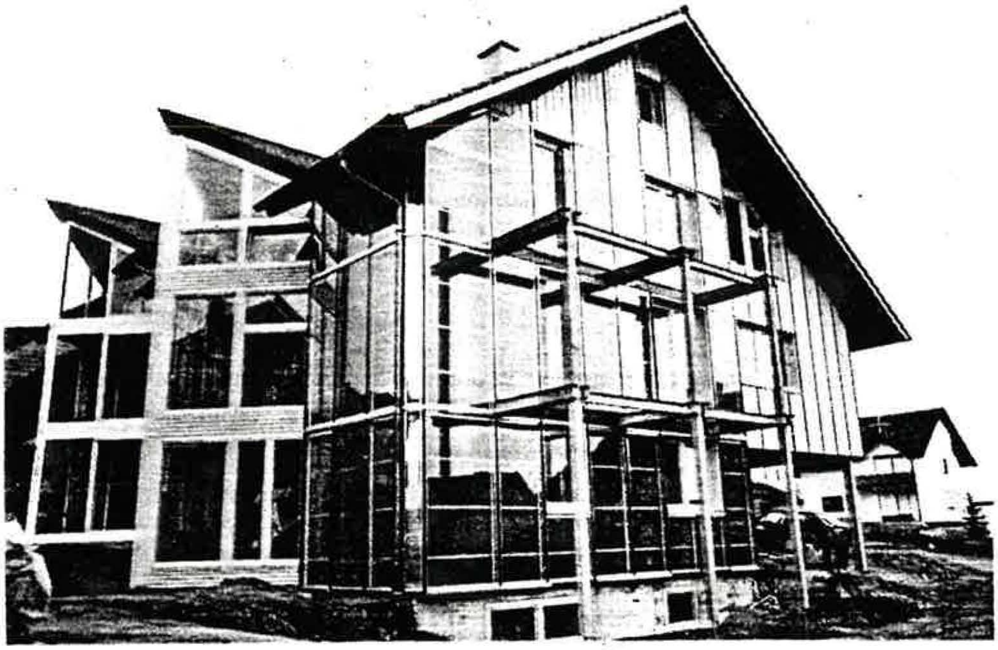

Fig. 1: View of the transparently insulated house in Freiburg Tiengen

Introduction

During the last years TIM was characterized in labs and TIM-modules were tested in - and outdoors as a cover of building facades or new collector constructions. Various simulation runs have proved the efficiency of TIM applications for solar heating purposes. Finally, feasibility studies have shown that TIM could give new impulses to building architecture. To demonstrate the potential of TIM it is necessary to build a new generation of solar houses which could meet demands such as

* E. Bollin is employed by the Fraunhofer Institut für Solare Energiesysteme (ISE)

- the efficient handling of the building's thermal energy in - and output
- the integration of large areas of solar components into the building's facade without disturbing the building's appearance
- saving investment costs by consequent planning

The building, shown in fig. 1, gives an example of a new type of solar house incorporating TIM. The design of its solar components is based on the research and development of the ISE. The design of the building construction was done by CEREC in Ardon (CH). The management was done by Planerwerkstatt in Vörstetten and by the author. The TIM facade was designed by the author. The Schmidt company in Freiburg was the consultant. This building is financed privately by the Bollin and Oelhaf family and Mr. H. Gessler.

The building

The building, situated in the south-west of Freiburg, was erected in 1988 and has been occupied since December 1988. It is not a scientific project but a solar house with two occupied apartments. This building with its realistic solar energy concept is surrounded by conventional newly built houses. It is a semi-detached building and its ridge is oriented from the north-west to south-east. It has 2.5 storeys, about 190 m^2 living area and a volume of about 1200 m^3. The south-east and the south-west facade are partly transparently insulated. For domestic water heating a solar storage collector is integrated into the south-west TIM-facade.

The design is the result of an energy concept with different temperature zones, with direct solar gains through windows and indirect gains through the TIM facade. During periods with low solar radiation and outside temperatures, two separately placed tile stoves fired with wood ensure agreeable room temperatures.

The TIM facade design

For solar heating purposes 37 TIM modules with a total area of 61 m^2 were installed.

The modules were prefabricated with integrated

- 10 cm polycarbonate-Honeycombs delivered by the AREL company
- 30 μm Hostafon foil, which covers the TIM at the wall side
- a roller blind with an aluminium coating supplied by the REMIS Company in Köln.

This construction is covered with a tempered low iron float glass with an aluminium frame which can be swivelled. The TIM was delivered in blocks of 0,7 m width, which can be easily mounted into the infilling inside the wooden frame.

Fig. 2 shows a cross section of the TIM module prefabricated at the Schmidt Company in Freiburg. The TIM-modules were mounted on stainless steel angles which are fixed to the black painted massive masonry. This masonry consists of bricks of 24 cm width, a density of 1.6 t/m^3 and a heat conductivity of 0.68 W/mK. After the modules were fixed to the wall, the air gaps between the TIM-modules and between the opaque insulated facade were covered with aluminium strips to protect against weather. The vertical cover strip is painted red to match the red wood cover of the opaque facade. This gives the Tiengen TIM-house its typical appearance.

During the seasons of the year the building changes its appearance due to the operation of the roller blinds inside the TIM facade. During summer the roller blinds are closed and the highly reflective coating of the fabric protects against overheating. During winter these blinds are opened in day time to let solar radiation transmit through the TIM and are closed at night time for better insulation.

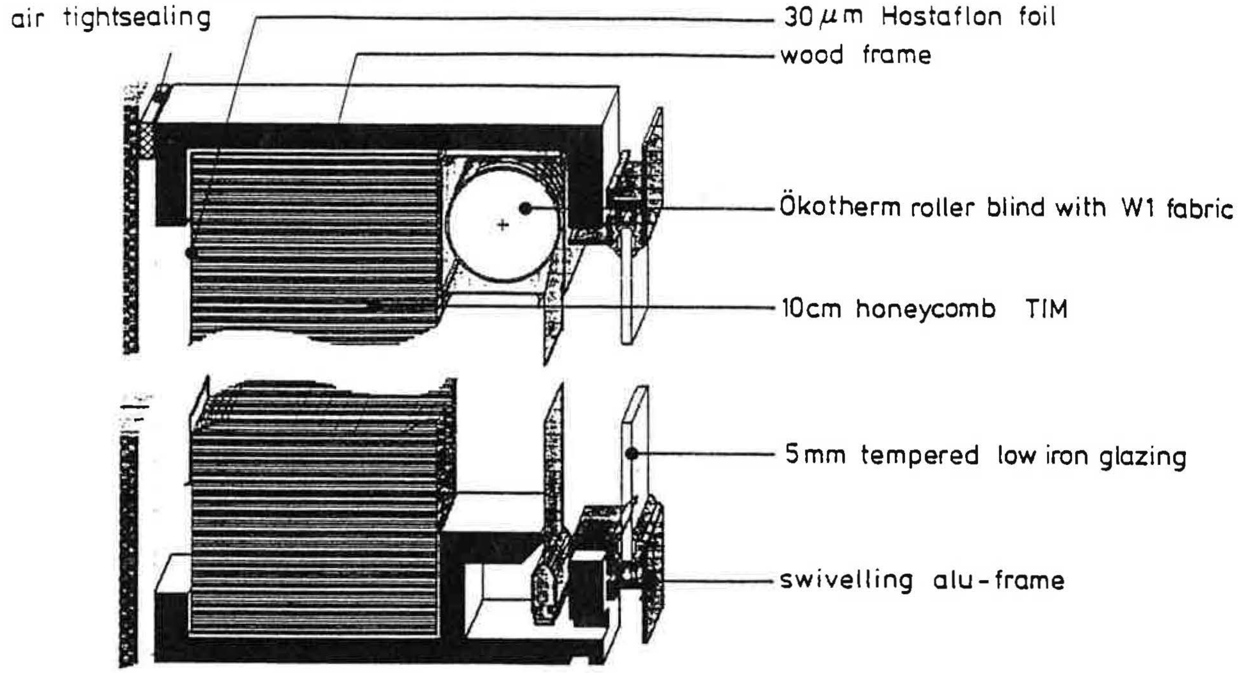

Fig. 2: Cross section of the TIM module prefabricated at the Schmidt Company, Freiburg

Integrated storage collector

Based on the research and development of the ISE which results in the so-called "Speiko" /1/, a solar domestic water heating system was designed. Fig. 3 shows the cross section of the storage collector. The collector tank with a volume of about 255 l and a length of about 5.2 m was installed vertically into the south-west facade so that the transparent facade construction could cover the tank without disturbing the appearance of the building. The collector components were fitted into a gap of about 0.8 m in the south-west masonry at the site .

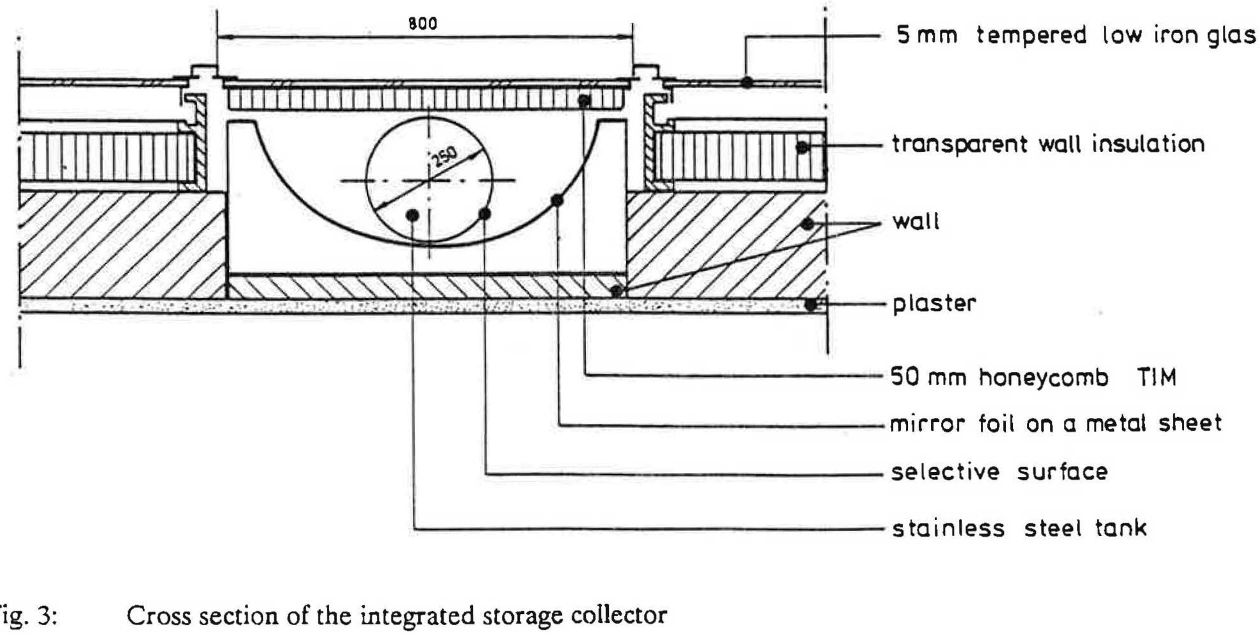

Fig. 3: Cross section of the integrated storage collector

Because there is no danger of freezing the system is filled with water. For auxiliary heating an electric boiler tank with a volume of 30 l is installed in both apartments. The collector tank is directly connected to the fresh water mains which has a pressure of about 6 bar. During operation if a hot water tap is opened in a bathroom, fresh water from the mains runs through the solar collector tank and hot water is transported to the bathroom. If the water temperature is below the required temperature the auxiliary heating system adds the temperature difference. This kind of operation allows even low solar energy input to be transformed into useful thermal energy. Control and regulation instruments are not necessary. The scientific research at the ISE shows that storage collector tanks integrated vertically in the building's facade could achieve a collector efficiency of 40 % and 60 % solar fraction /1/. To protect the occupants against scalding, and to prevent overpressure and boiling different security instruments were installed.
From December 1988 to August 1989 27 m^3 water passed through the collector tank and 530 kWh electric energy could be saved by solar energy. From these figures a 32 % solar fraction results for the nine months' period.

Summary

The experiences during the erection of the solar house show that solar components can easily be integrated during the construction of a building. From the architectural point of view it needs considerable efforts to create an appealing facade design combined with sufficient weather protection. The integration of the solar collector tank into the TIM-wall-construction a practical application.
The heating comfort inside a transparently insulated building is of new quality. Due to the higher surface temperature of the outside walls during the winter season lower air temperatures are still comfortable. The heating energy is mainly transmitted via long-wave radiation.
The use of the auxiliary tile stoves is adapted to the solar gains from the TIM-walls, the windows and the wintergarden. The occupants should handle the auxiliary heating system carefully to save energy and to keep a sufficient heating comfort inside the rooms.
During the winter period from December 1988 to May 1989 6 m^3 wood were burned in the two stoves which is equal to 10000 kWh. In order to appreciate this amount the high moisture inside the newly built construction and the incomplete insulation of the building's north-west facade have to be taken into consideration.
During the summer season the roller blinds inside the TIM facade protect adequately against overheatig and keep the house comfortably cool. Not least this also results from the sufficient regulation of the direct solar gains through the windows and the wintergarden by the roller blinds integrated inside the glazing construction.
In order to obtain detailed data about typical values like the wall's time constant, the heating comfort, the energy consumption of the auxiliary heating systems, the outside temperature and the solar gains of the building, a monitoring system, promoted by the ISE will be installed in October 1989.
The experiences gained while living inside and with this new generation of solar house demonstrate that sufficient heating comfort and adequate solar architecture are compatible.

Reference

/1/ Ch. Schmidt, Anwendung transparenter Wärmedämmung mit Wabenstruktur in integrierten Speicherkollektoren, Dissertation, TH Darmstadt 1988.