The Centre for Sustainable Building
A Case Study

(ZUB*)

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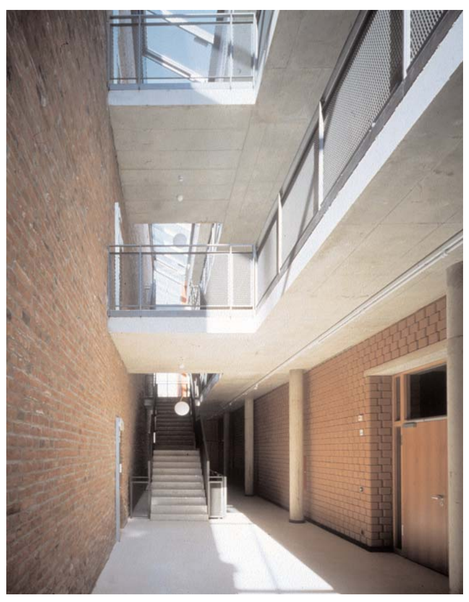

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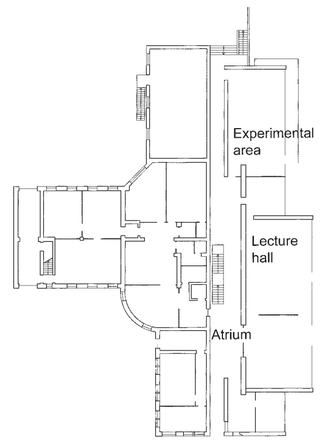
Energy efficient building with the lowest possible impact on our natural environment is much more than a demand, it is a need in the entire building process.
The ZUB office building is an example of how new low temperature heating / cooling systems and strategies have been implemented and new environmentally friendly building materials can be used. It illustrates how new efficient systems and strategies can be realised in practical building projects.

THE BUILDING CONCEPT

The office building of the Centre for Sustainable Building is situated at the University of Kassel, in an old urban neighbourhood. The new building of the ZUB closes a gap between an ensemble of old houses. An atrium, used as a light gap, which contains the entrance zone and the staircases, joins the old brick building of the Faculty of Architecture to the modern concrete construction, joining them to form a combination of old and new.

The ZUB office building consists mainly of three different parts: one part for exhibitions and events, one part for offices and an experimental part for different kinds of research in building technologies. On the flat roof, some space has been provided for test equipment in non-shaded conditions.
The load bearing skeleton in reinforced concrete consists of round pillars with a distance of 5.40 m and flat concrete slabs for the floor / ceiling construction. The U-value of the exterior walls is 0.11 W/m²K and triple glazings with a U-value of 0.6 W/m²K have been chosen for the mainly south facing large window area. The minimal frame-fraction of the wooden facade construction helps to reduce heat losses and the problem of thermal bridges has been diminished by the careful planning of all joints and details. A good thermal insulation is mandatory in achieving minimal heating energy demand for the entire building.



Floor plan (of the ZUB building), ground floor

Main building facts

Volume	6882m³
Net floor area	1732m²
Main floor space	830m²
Area/volume ratio	0.34m^{-1}

Building part	U-value
Exterior walls	0.11 W/m²K
Roof	0.16 W/m²K
Windows	0.80 W/m²K
Wall/floor against ground	0.26 W/m²K
Mean U-value	0.32 W/m²K

Primary energy demand for heating (acc. EN 832) 17kwh/m²a

THE ENERGY CONCEPT

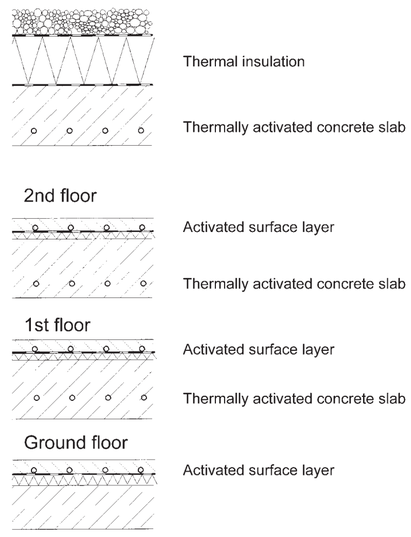
The office has been planned as an example of a low energy building. The planned annual primary energy demand for heating was projected as 17 kWh/m²a, which is only 30% of the limiting maximal value, according to the German Energy code EnEV.
To save electrical energy, both natural lighting and even ventilation strategies have been implemented. Solar gains are utilised through the glazing of the south facing façade. At the same time, a good thermal and indoor comfort for the occupants was a major demand from the building owner.
To monitor the aims and verify the concepts and achievements, an intensive research project for "solar optimised building" (Solaroptimiertes Bauen; research programme funded by the German Ministry of Economy and Technology) is currrently being run. Over a period of four years, all the planning and construction processes are being followed up and, for at least two years, measurements of all important parameters of this building are being drawn out. Approximately 1300 measurement points, such as temperatures and heat and energy flows, are being monitored. In addition, the thermal / indoor comfort and indoor air quality is being reported and controlled. Studies on the building behaviour are being done in two especially equipped office rooms. Detailed system studies on components (heating and ventilation system) are being drawn out.
Furthermore, the ZUB office building is a demonstration project for the IEA ECBCS Annex 37 "Low Exergy Systems for Heating and Cooling of Buildings".

Systems for heating and cooling

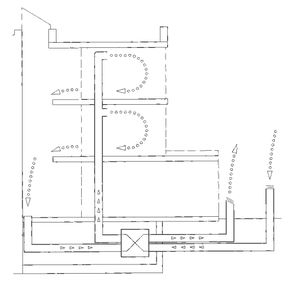
To achieve the heating and cooling of the offices using one system, only a hydronic conditioning system with embedded pipes has been chosen. In the case of heating, the system works with low inlet temperatures . When cooling is necessary, pipes in the floor slab construction of the basement, the ground heat exchanger, cool the water. Ground coolness, a renewable and environmental energy source is utilised.
The pipes are embedded in the concrete floor slabs and in the upper floor construction. The slabs are thermally activated and in addition, a conventional floor heating system has been placed on top of them to test the properties of different systems and their advantages. Since each room has its own heating circuit, individual regulation of the thermal conditions is provided.
The thermal comfort in these offices is very high because of the even and relatively high surface temperatures.

Ventilation strategies

To reduce ventilation heat losses, mechanically balanced ventilation using heat recovery with two cross flow heat exchangers in a series and a thermal efficiency of 0.8 has been installed. In the normal operation mode, fresh air is supplied directly to the office rooms and exhaust air is extracted from the atrium. For research purposes, the air flow direction is reversible. The fresh air can be supplied to the central atrium and the exhaust air extracted from the office rooms.
The air flows are regulated via indoor air quality sensors (VOC) and the ventilation is demand controlled. When the overall delivered airflow is not sufficient, the offices are ventilated by natural means. The building structure is cooled during the night by a massive natural flow of cold ambient air.



Position of the different layers of pipes in the concrete slabs



A ventilation strategy: fresh air supply directly to the offices and return air via the atrium

THE CLAY WALL

There is a clay wall, made from massive unbaked clay bricks, in the centre of the building and on all floors. This wall, with its great heat capacity and the capability of dampening fluctuations in humidity, can be seen as a climate wall. It also provides the space necessary for electrical and ventilation installations. The function of this wall is also monitored.

CONCLUSION

The ZUB building is actual proof that it is possible, using today's construction technology, to combine the demand for energy efficiency with sustainable building. This can only be achieved by having a well-designed integral planning process and a close teamwork of all participating parties. An example of this is, shown by ZUB, where the hydronic heating/cooling system has been merged into the building structure, an entirely new challenge for planers and builders. Measurements (Approx. heating energy 26.7 kWh/m²a, approx. electricity consumption 10.7 kWh/m²a) of the first heating period, indicate that the demand for low energy use has been fulfilled.

ACKNOWLEDGEMENT

The author wants to thank the German Ministry of Economy and Technology and the Swedish Council for Building Research for financing the research work on this project.

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www.zub-kassel.de