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COMPUTER SIMULATIONS OF A COMMERCIAL BUILDING WITH TOP COOLING

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ABSTRACT

In the introduction the application of low energy cooling method for commercial buildings in the middle Europe is discussed. The main part of the paper deals with modelling and simulation of building it self and HVAC system including control. The calibration of the ESP-r building model according to measured data is prescribed and problems with system simulation are discussed. The role of modelling and simulation for low energy cooling is presented on the conclusion.

BUILDING CONCEPT

The new headquarters for ČEZ , a.s. in Prague (1998 - 2002) is the first headquarters building in the Czech Republic to employ night-cooling and natural ventilation for most of the office spaces, supplementing part of the mechanical cooling and ventilation supply systems. During the initial design process computer simulation was apled to prove the chosen conception of night-cooling and natural ventilation. Occupied by ČEZ since April 2002, the new headquarters won the "Building of the Year" award by Czech foundation ABF in September 2002 (Dvorak 2002).

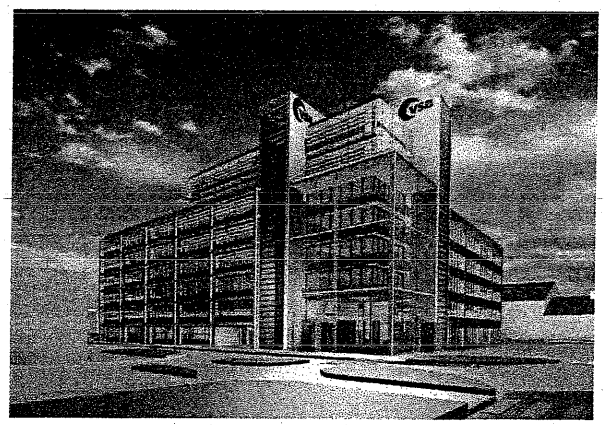

Figure 1 Visualization of the CAD model of the building

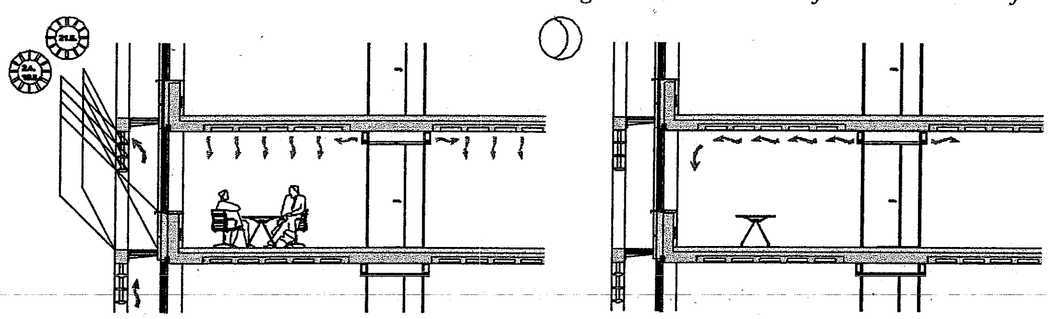

Figure 2 Principle of the daytime shading and nighttime forced ventilation

MEASSUREMENTS

There are three different kind of meassured data available. Firstly data provided from the control system of the building. Secondly the long time monitoring of the inside temperature and humidity and some more detail measurements of temperatures and velocity distribution inside the building and on the system diffusers. And finally outside climatic data from the CTU meteorological laboratory. All the three sets are used for calibration of the CEZ building model.

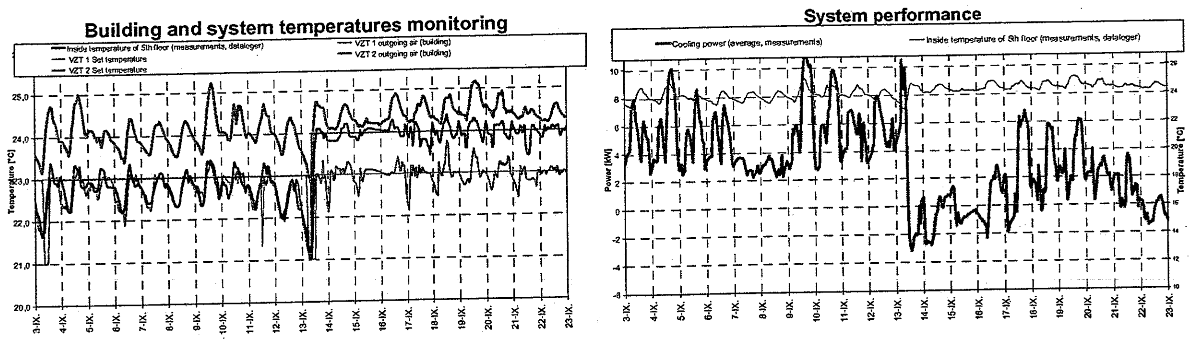

Figure 3 The building and its system monitoring

BUILDING MODEL

The ESP-r model of the 5 floor in the annex A was chosen to represent the problems in the big part of the building. One zone model including all detail structure description, shading properties and internal gains was set up. The geometry is simplified on a few points. At the first few internal office blocks and toilets block which are separated from the rest of the floor by internal walls are not consider as different zones because of the same type of control of this blocs as the rest of the office area and the influence if the thin and light internal walls is negligible.

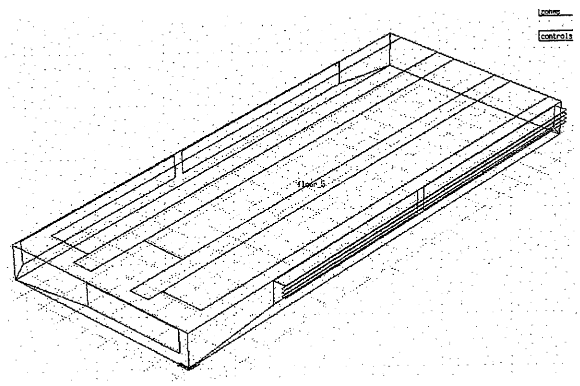

Figure 4 The ESP-r model of the 5th floor of the building

BUILDING MODEL CALIBRATION

The ESP-r model calibration is very important part of the real building modelling. The aim of the calibration is set up the not certain inputs to the building model according to measured performance of the building. Calibrated model ca be used to predict performance of the building for different condition, for example to optimise the system control strategy.

For most office buildings the internal gains from office equipment are the most important parameter. The are two reasons. Firstly for well insulated and shaded building the internal gains represents biggest part of all gains. Secondly real performance data are never available. Previous research (Duška 2004) shows the rate of real average power consumption (heat production) to nominal (nameplate) is from 5 to 60 percent for office equipments.

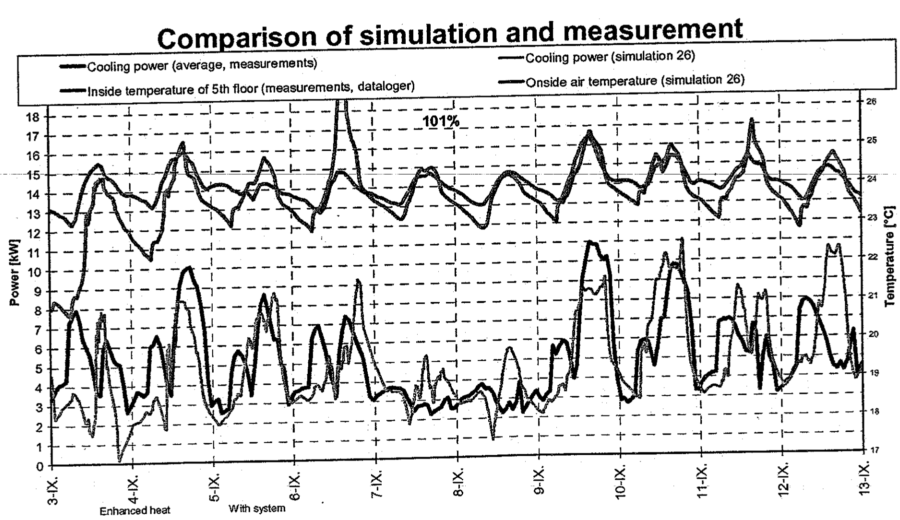

Figure 5 Comparison of the building measurements and simulation results set 1

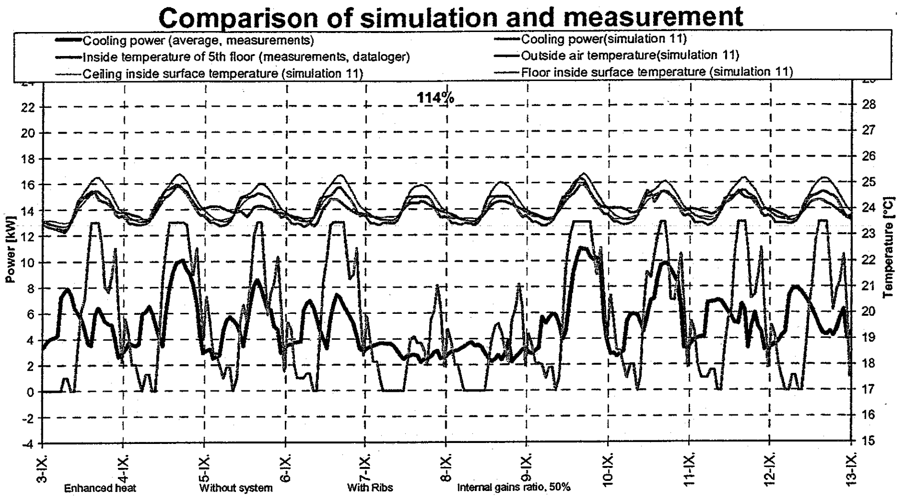

Figure 6 Comparison of the building measurements and simulation results set 2

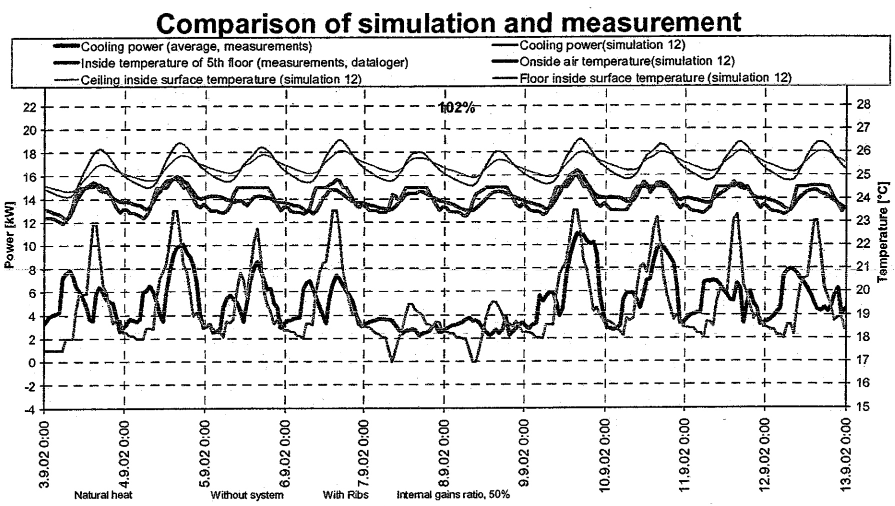

Figure 7 Comparison of the building measurements and simulation results set 3

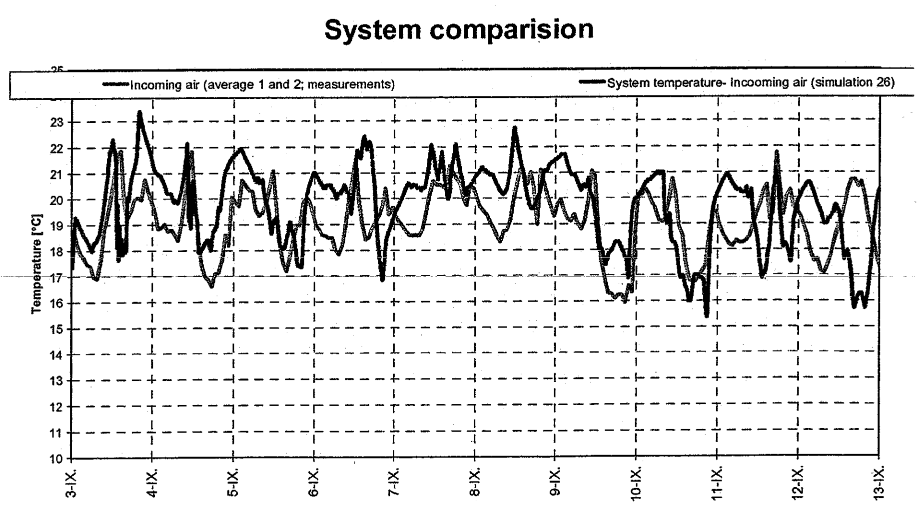

Figure 8 Comparison of the system measurements and simulation results set 1

CONCLUSION

The ESP-r simulation results analysis performed within calibration point out the following issues. The heat transfer coefficients model play the important role for the simulation. When standard heat transfer was used the energy consumption and load profile are more close to measured, but the inside surface wall temperatures are high. If the increased heat transfer is applied the wall temperatures are close to air temperatures, but the load profile and consumption for building simulation diverse from measured. To be able to find proper solution additional measurements will be done this summer, to find out the surface temperatures inside office.

Simulation of the building including the air-conditioning system finally agree better with measurements but, there are few problems with some fluctuations and difficulties with system simulation using ESP-r plant simulation.

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