#6129

Design aspects of naturally ventilated offices in The Netherlands

by P.H. Wapenaar, Adviesbureau Peutz & Associés BV, The Netherlands

During the last decade air-conditioning has become increasingly popular and affordable. As a result, many new offices are automatically equipped with air-conditioning systems even when natural ventilation may suffice.

In this article, a case is presented for the use of natural ventilation in a new office building. The designers of the new town hall in Apeldoorn, the Netherlands, have tried to avoid installing a complete air-conditioning system by exploiting all the natural possibilities which the building/construction offers to create a proper thermal climate. To achieve a high quality, both from a building physics and an energy point of view, certain functional, building, and HVAC design parameters have been determined at an early stage.

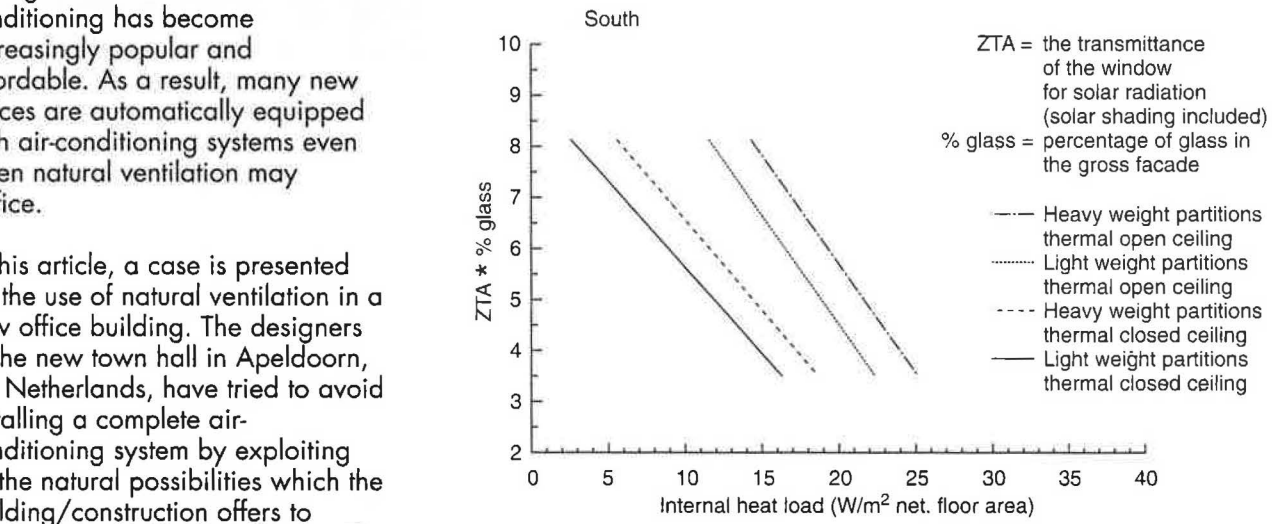

Figure 1: The relation between the design parameters for a typical 20 m² office for 2 people (offices facing south).

The most important parameters are: the quality of the building shell, the system of natural ventilation throughout the building, the use of heat and cold storage in the building mass, and the heat input due to internal heat loads.

To determine these parameters several design aids have been developed with the assistance of computer simulations.

Figure 1 shows the relation between the design parameters for a typical 20 m² office for 2 people. This design-aid represents, the balance between the external heat load due

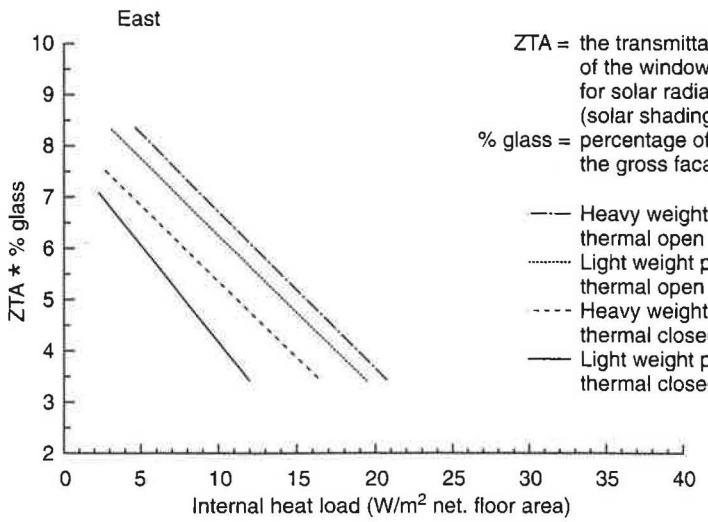

Figure 2: The relation between the design parameters for a typical 20 m² office for 2 people (offices facing east).

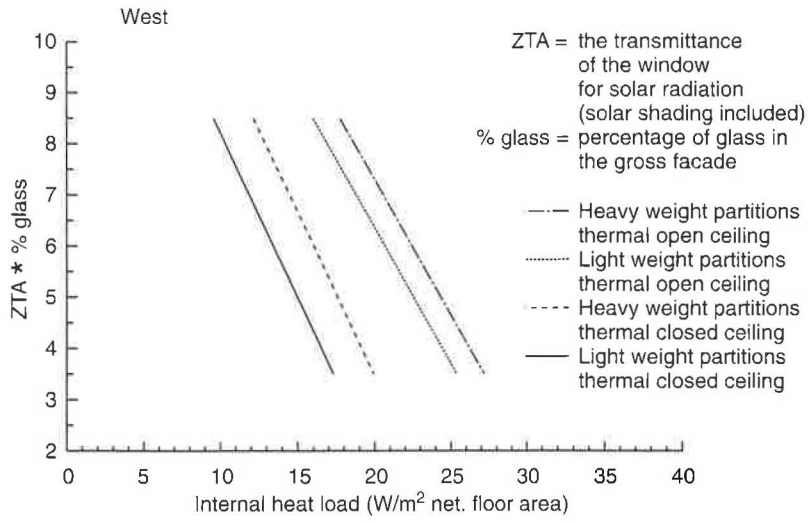

Figure 3: The relation between the design parameters for a typical 20 m² office for 2 people (offices facing west).

to solar irradiation, and the corresponding allowable internal heat load for south facing offices. The four lines in the figure are related to different levels of available heat capacity in the office space, varying from light weight partitions (gypsum board) and a closed ceiling to heavy weight (brick) partitions and a so- called thermally open ceiling (or no false ceiling).

Furthermore, the design-aid is based on consciously regulated natural ventilation in the office, day and night. This will result in the inside air temperature level exceeding 25°C only during about 2% of the office hours per year and never exceeding 28°C during an average summer.

Similarly, in Figures 2 and 3 the design-aids are given for the offices facing east and west.

A research project has been commissioned by the Netherlands Agency for Energy and the Environment to determine comparable design aids for additional ventilation of office rooms where windows which can be opened [1].

The offices of the town hall are naturally ventilated. Each room has a window which can be opened. Furthermore, each office has an additional small ventilation window of 0.2 x 0.2 m² to enable safe night-time ventilation. Night-time ventilation is necessary because it makes use of the heat storage in the mass of the concrete floor. The corridors of the office section of the building are interconnected by an atrium. This atrium plays an important role in the mechanism of night-time ventilation; it provides the driving force during periods of low wind speeds outside. During winter, autumn, and spring the small ventilation windows provide the required fresh air supply.

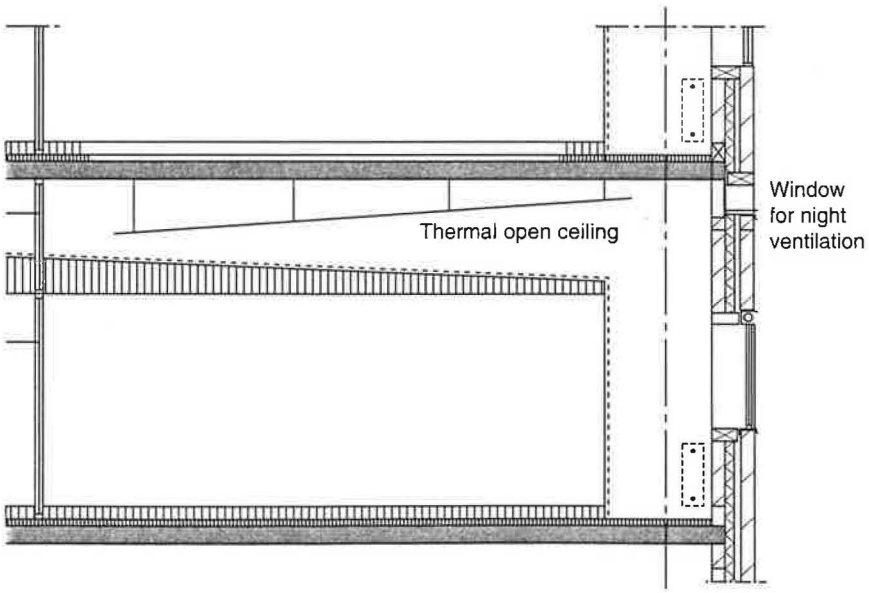

Figure 4: Thermal open ceiling and window for night ventilation.

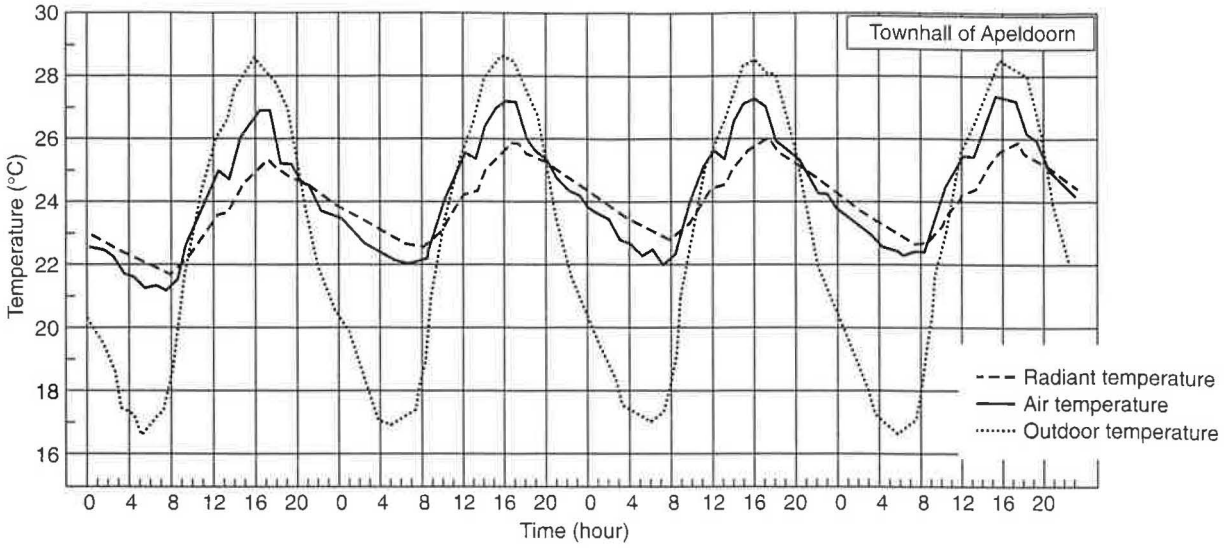

Figure 5: Results of measurements taken in the climate chamber

In the offices, a thermally open ceiling is implemented in the form of free hanging ceiling boards (Figure 4). The walls are made of white painted brick to enlarge the available heat capacity in the offices.

The maximum percentage of glass on the facade is approximately 25%. Furthermore, the sunlit parts of the facade are provided with solar shadings outside.

Under these conditions, a total internal heat load of 25 Watt per m^2 appears to be feasible. With the lighting system as proposed by the architect, the internal heat load allows the use of one personal computer configuration per person.

To confirm the concept of natural ventilation and thermal storage, several dynamic measurements on the thermal behaviour of offices have been carried out in the climate test chamber of Adviesbureau Peutz & Associés BV, Molenhoek, The Netherlands.

Figure 5 shows the results of measurements carried out in the climate chamber. The figure includes the air temperature as well as the mean radiant temperature during a surveillance period of four days. The simulated outside conditions are related to a hot sunny day in July, with outside temperatures between 16°C and 28°C. From the results it can be derived that during this period the average room temperature never exceeded 28°C, which is in accordance with Figure 1. The inside temperature remained below the outdoor temperature. The significant difference between air temperature and mean radiant temperature is striking. This is a direct result of the amount of mass available for heat storage during hot "peak" hours. It is well known that especially the radiant component of the room temperature has a beneficial influence on thermal comfort.

Depending on the heat production of the radiator, the air velocity in the occupied zone did not exceed 0.15 to 0.25 m/s during winter simulations. Therefore, discomfort caused by draught is not expected.

To conclude, it is clear that the integration of several natural climate control options can result in a sufficient standard of comfort. How to do this is well known as far as the physical properties of the building shell and possibilities of heat/cold storage in the building mass are concerned.

There is still more work to be done however in the field of natural ventilation in offices. Draught-free ventilation, especially during the winter, is an important aspect that still deserves a lot of attention. Of course, much can be learned from the past, resulting in novel approaches and solutions, especially in the case of high rise buildings.

For more information please contact:
Ing. H.B. van Eck
Novem B.V.
P.O. Box 17
6130 AA Sittard
The Netherlands

[1] Design aspects of naturally ventilated offices, report E 234-1, (in Dutch), Adviesbureau Peutz & Associés BV, The Netherlands, 1992.