#7560

Intelligent Building Saves Energy

Unique air flow windows and dual air-conditioning systems provide occupant comfort and energy conservation

By Katashi Matsunawa and Fumio Nohara
Member SHASE Member SHASE

The NEC high-rise headquarters in Tokyo, Japan, was designed to be the most advanced intelligent office building of its kind anywhere. In designing this building, our goals were to support the functions of intelligent systems, to maintain the indoor environment at a constantly comfortable level, and to simultaneously achieve energy conservation.

To achieve these goals, we first installed a "wind avenue" to reduce the wind damage to the building. The wind avenue enabled us to design the high-rise building with north/south oriented windows, which are preferable to enhance the occupants' comfort under the dominant seasonal north/sound winds in Japan.

Then applying the results of our energy analysis to account for environmental impacts, we utilized a double-skin glazing system, so-called "air flow windows" and other energy conservation systems. As a result, significant energy savings were achieved. In contrast, other intelligent buildings consume lots of energy.

The NEC high-rise headquarters building in Tokyo, Japan.

Air flow windows

The greater the depth of a given roo the more that room's interior requires co ing throughout the year. This ratio is part ularly notable in intelligent office buildin

About the authors

Katashi Matsunawa is the general manager c the mechanical and electrical engineerin department of Nikken Sekkei Ltd., Toky Japan. He received his master of architectu degree from Waseda University. Matsunaw is a member of the Society of Heating, Ai conditioning and Sanitary Engineers c Japan (SHASE) and an accredited consul ing engineer of mechanical engineering.

Fumio Nohara is a senior mechanical eng neer with the electrical engineering depar ment of Nikken Sekkei Ltd. He received h master of architecture degree from Wase University. Nohara is a member of the Soc ety of Heating, Air-conditioning and Sar tary Engineers of Japan (SHASE) and accredited consulting engineer of mechani engineering.

Intelligent Building Saves Energy

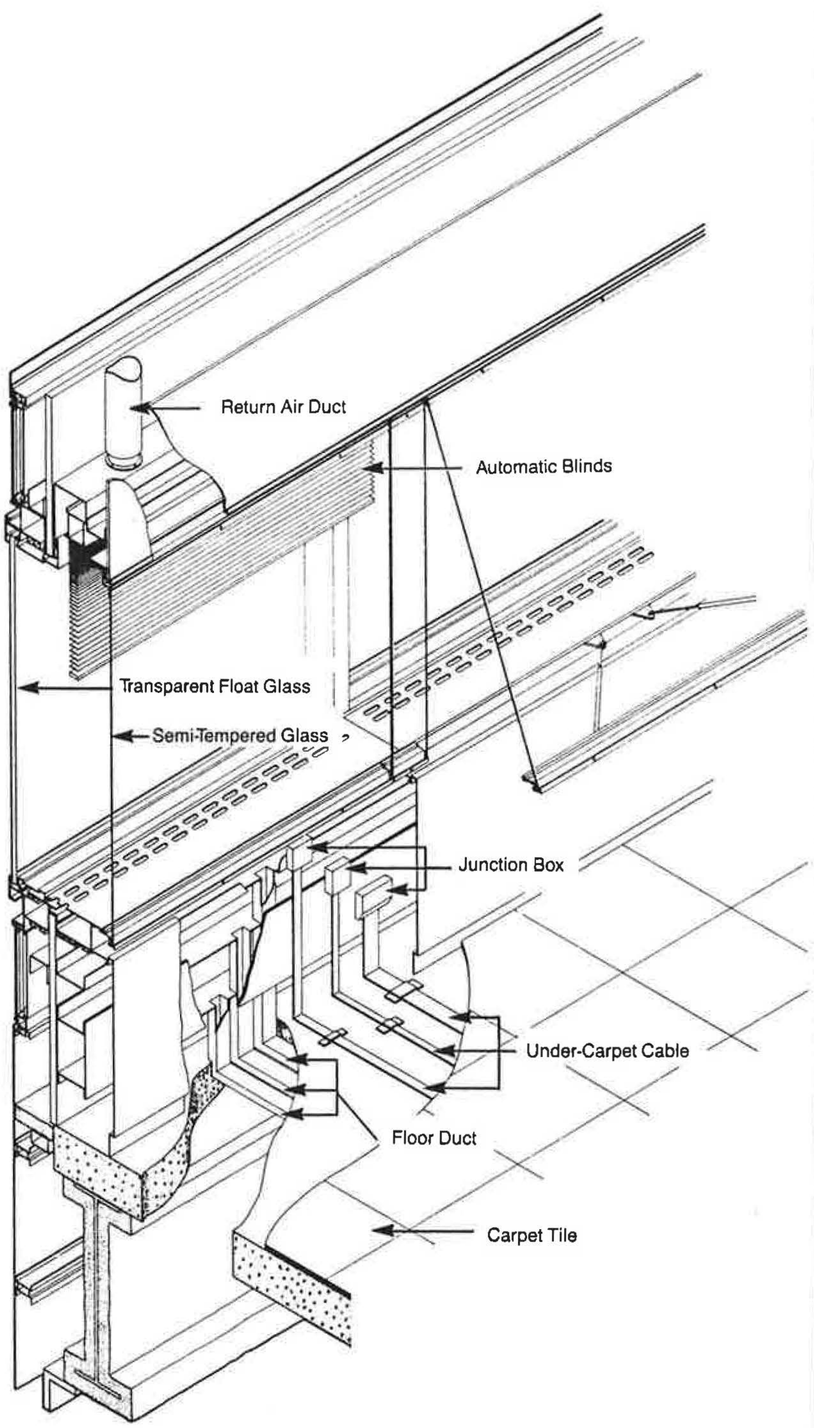

Figure 1. Sectional view of air flow window and open duct for wiring space.

On the other hand, such offices require heating around the perimeters in winter if the windows' insulation is poor. This causes a cross-mixing of warm and cool air in the space between the perimeters and the interiors, resulting in a substantial waste of energy.

To avoid such waste, we provided air flow windows and achieved a perimeterless air-conditioning system that eliminates cross-mixing (see *Figure 1*).

Figure 2 demonstrates the results of Predicted Mean Vote (PMV) calculations based on the field measurement of the indoor environment in summer and winter in a room with south-oriented windows. *Figure 2* also shows that, despite the use of a perimeterless air-conditioning system, a comfortable thermal environment was achieved.

Decentralized, concealed A/C

In intelligent office buildings, reduction of the fan-driving power is an indispensable part of any energy conservation program. Therefore, we adopted decentralized types of air conditioners in this project.

These air conditioners, which are concealed in the plenum, are installed at an interval of approximately 110 m^2 (1,184 ft^2). This minimizes the transport resistance (see *Figure 3*).

The use of a variable air volume (VAV) control system using an invertor further enhanced the reduction of the fan driving power.

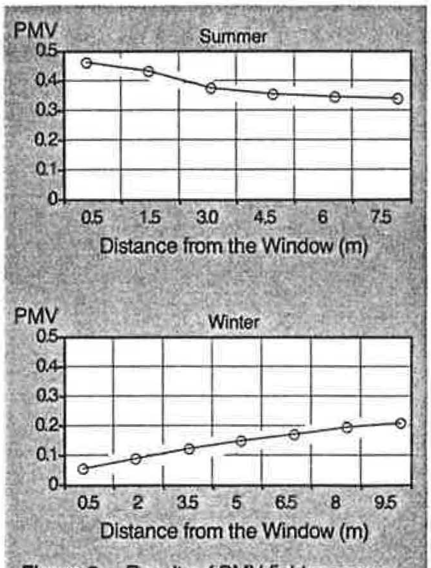

Figure 2. Results of PMV field measurement.

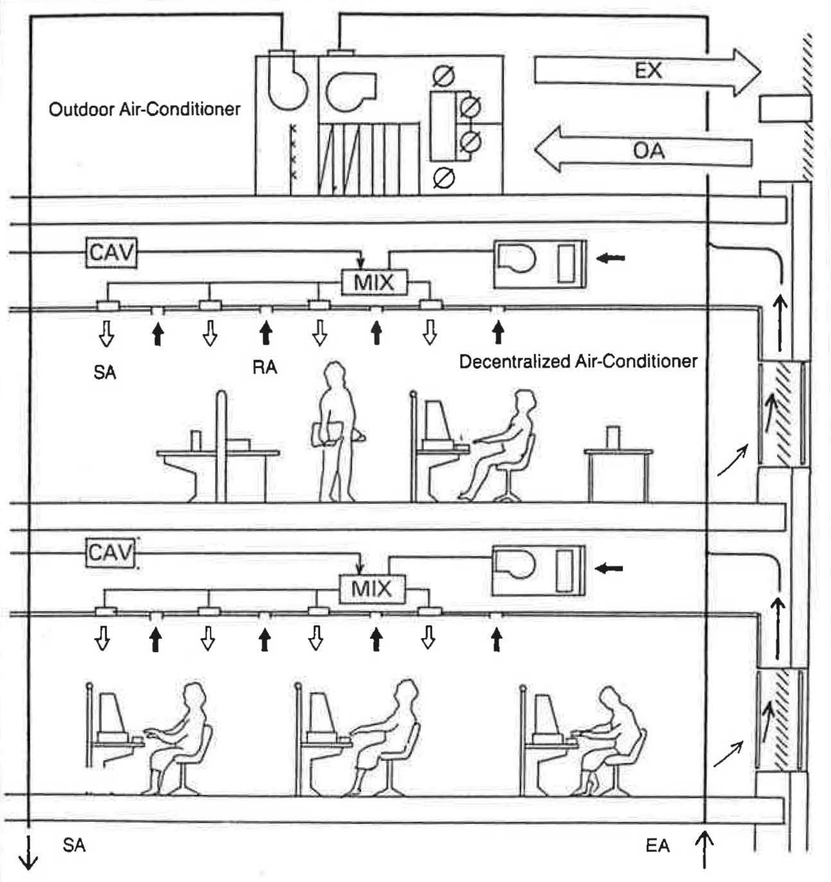

Figure 3. Air-conditioning system of typical office floors.

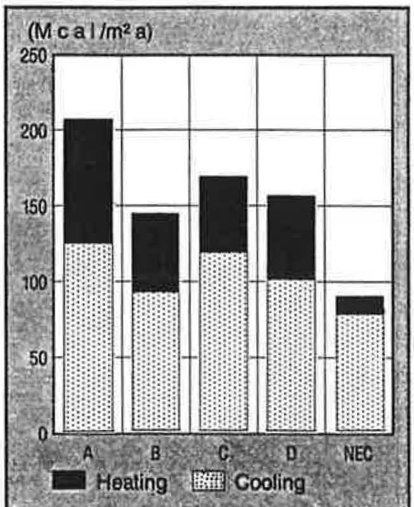

Figure 5. Comparison of annual heating/cooling energy consumed in large Tokyo buildings.

Outdoor air conditioners

The air-conditioning systems adopted for the typical floors of the building dually and concurrently condition the outdoor air (through cooling, dehumidifying, heating and humidifying) and the indoor air (cooling of the sensible heat generated in a room).

The reason for this "division of labor" is because, as long as the two cooling systems are of a completely different nature (total heat cooling versus sensible heat cooling), they should not be mixed.

To be more specific, one system supplies chilled water of a relatively low temperature to the outdoor air conditioners, which then perform dehumidifying functions. The other system supplies chilled water of a relatively high temperature to the decentralized air conditioners, which then cool the sensible heat. The heat source system as a whole improves the COP of the chiller, thereby contributing to energy conservation.

Energy consumption results

The total annual primary energy consumed was 482 $Mcal/m^2a$ (177,710 Btu/ft^2/year). The ratio taken up by lighting systems and receptacles accounts for more than 44% of the total. This is considerably larger than general office buildings where the ratio is estimated to be about 33% (see *Figure 4*).

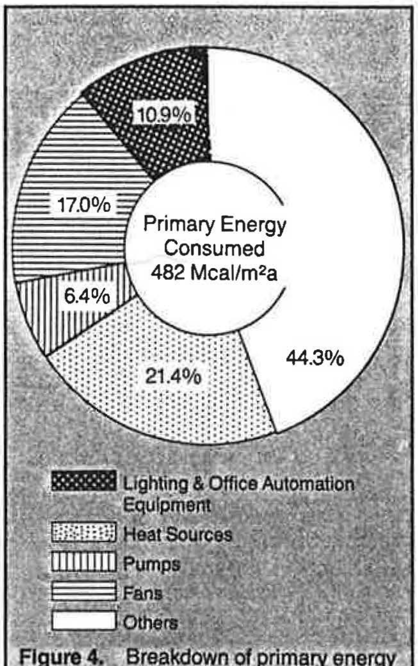

Figure 4. Breakdown of primary energy consumed in NEC buildir

Comparison was made with office buildings of similar scale in *Figure 5*, so that the unique features of heating/cooling energy consumption of the NEC office building can be more fully understood. As shown in this figure, the energy consumption for heating is very when small compared with that consumed for cooling.

The results clearly show that the energy consumed for heating in our project is extremely small when compared with those of other buildings. We believe this is the result of the combined effects of the air flow windows (which eliminate loads at their "roots"), the perimeterless air-conditioning system (which prevents cross-mixing), and the division of labor of the air-conditioning system (which is free of reheating through dehumidification). ■

Reader Response Rating

ASHRAE Journal would like to ask that you rate this article now that you have read it. Please circle the appropriate number on the Reader Service Card to be found at the back of the publication.

Rating:

Extremely Helpful 476
Helpful 477
Somewhat Helpful 478
Not Helpful 479