THE LIBERTY TOWER, MEIJI, JAPAN

<table>
<thead>
<tr>
<th>Building name:</th>
<th>The Liberty Tower of Meiji University, Japan</th>
<th>Year of completion:</th>
<th>1998</th>
<th>Type of building:</th>
<th>Educational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Team:</td>
<td>Architect / Structural Design / HVAC Design / Electrical Design / Environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Site data

<table>
<thead>
<tr>
<th>Design conditions</th>
<th>Design conditions</th>
<th>Average wind speed (m/s)</th>
<th>Prevailing wind direction</th>
<th>Terrain shielding</th>
<th>Dust pollution</th>
<th>Noise pollution</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>winter T g/kg</td>
<td>summer T g/kg</td>
<td>3.4</td>
<td>17.5</td>
<td>2.8</td>
<td>NNW</td>
<td>flat</td>
<td>35.42</td>
<td>139.46</td>
<td>12</td>
</tr>
</tbody>
</table>

Design philosophy for IAQ and Thermal Comfort and issues of concern for this building

With the natural ventilation system, the automatically-controlled ventilation windows are open when the outdoor air is thermally comfortable enough. Because of the large air volume of fresh outdoor air obtained by natural ventilation, and because fresh air is supplied upward from openings under windows, IAQ is improved.

With the mechanical air-conditioning system (when natural ventilation is not functioning because the outdoor air is not comfortable enough), the supplied air flow rate is controlled by a VAV system, and the mixed air volume of fresh outdoor air is automatically controlled based on indoor CO₂ concentration for energy savings and IAQ.
Principle of Hybrid Ventilation

During the design process of the building, several testing methods were carried out to test the efficiency of the various components used in the principle of hybrid ventilation system design. The “wind-floor” concept, whereby the central core is designed as a stack-effect to induce natural ventilation at each floor, is the special design feature of the building. The various other measures taken to improve the quality of indoor environment include the use of automatically controlled natural ventilation windows during night time, an automatic outdoor air intake, and a proper building environment and energy management system that takes advantage of the optimum outdoor air quality and temperature to cut energy consumption costs of the building.

Components used to solve main issues or problems

**IAQ control:** CO₂ sensors to control the air volume of mixed outdoor fresh air

**Temperature control:** Temperature sensors positioned in a room or zone area.

**Energy conservation:** BEMS.

**Control of airflow rate:** VAV system controlled by BEMS (mechanical air-conditioning system). Windows are automatically controlled (natural ventilation system).

**Security:** Natural ventilation openings are small enough to prevent invasion. They are covered by steel net to protect against birds.

**Acoustic privacy:** Silencers between each room and corridor

**Fire regulations:** Smoke sensor

**Maintenance:** Periodical inspection and supervision by BEMS

Control Strategies

Automatically controlled natural ventilation windows and wind floor design (18th floor). Automatic outdoor air intake control system based on CO₂ sensor. Building environment and energy management system.

Particular control strategy issues

The general architecture of the control system is a centralised supervisory control. In principle, operation is by the centralised system. The type of management is internal

Overall performance

The use of the natural ventilation system reduces the cooling energy of the building considerably, ranging from 90% in April (Spring) through to a minimum of 6% in July (Summer), and continues to reduce cooling to around 62% in November (Autumn). The wind floor design at the 18th floor, incorporating the automatically-controlled ventilation windows at each of the other lower floors, increases the ventilation rate by 30%.

The overall performance of the building, based on the hybrid ventilation system on top of the optimisation of the building shape to obtain the advantage of the solar geometry, managed to achieve the following savings in energy consumption:

Coefficient of Energy consumption for air conditioning : 52% of Japanese Codes

Coefficient of Energy consumption for ventilation : 52% of Japanese Codes