Sapporo transportation bureau office, Sapporo (Japan)

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6. Sapporo Transportation Bureau Office, Sapporo (Japan)

Owner:	*Transportation Bureau, Sapporo City*
Architect and Engineer:	*Nikken Sekkei (Hokkaido) Ltd.*
Contractors:	
Building:	*Iwata Construction Co., Ltd. and four others*
Mechanical:	*Goken Kogyo Co., Ltd. and four others*
Period of Construction:	*16 months*
Completion:	*November 1982*

The city of Sapporo, situated at lat. 43°N, is the largest city in the north of Japan. In winter the mercury frequently falls to more than 10°C below zero, the average temperature of January being –5°C. There is a snowfall of 1.5 m or over. Summer temperature sometimes exceeds 30°C in July and August. The average solar radiation incident on a horizontal surface is 1.8×10^5 J/m^2 in January and 3.8×10^5 J/m^2 in July. Heating degree-days on a 20°C base amount to about 4000 degree-days.

This office building was constructed together with a separate training center, in lieu of the old building which had become too small and old for use. To facilitate communications with fields and other municipal offices, the new building was sited in a different, larger place, 11815 m^2, adjoining a station of the subway line extended concurrently.

The building, having eight storeys with a basement and a penthouse, is 1262 m^2 in building area and 10088 m^2 in total floor area, rising to 34 m above the ground level. The structure is mainly of steel framed reinforced concrete construction resting on the mat foundation. The amount of structural steel, reinforcement and concrete used for construction was 1020 tons, 1170 tons and 8960 m^3 respectively.

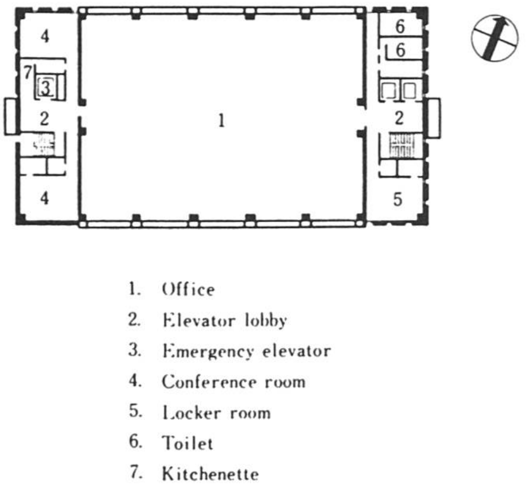
General view of the building

The planning of this building started in June 1980. With Energy Saving Law enforced a few months before, it became mandatory that PAL (Perimeter Annual Load)* and CEC (Coefficient of Energy Consumption)* be computed in designing office buildings having a total floor area of 3000 m^2 or over. In addition to such a regulative background, positive concern was given about energy-conscious design of the building. That is, every effort was made to achieve energy saving design not by applying such a superficial manner as reduction of window area or storey height, but by making a radical approach with creation of a comfortable, flexible office space in mind.

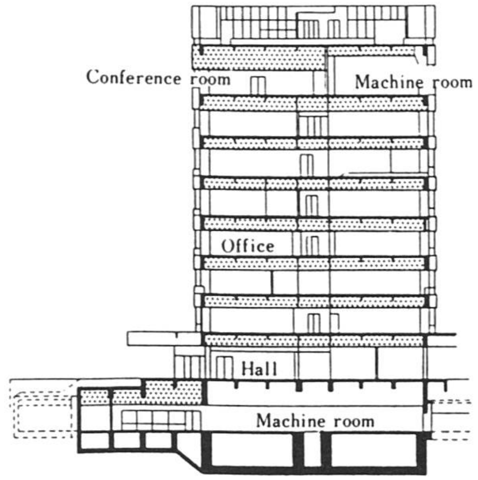
The optimum building configuration was first of all studied with the aid of the «PAL Table for Sapporo» which had been prepared by the firm in advance in order to make the energy approach more comprehensive and progressive than required by the Energy Saving Law. This table is based on 41472 building models which were obtained through extensive computer analyses by varying 10 factors related to annual heat load, such as floor area, number of storeys, length-width ratio, location of the core, glazing, heat transmission through exterior cladding, sun control and building orientation. As a result of this study, PAL of this building was taken as 1.63×10^8 J/m^2-year for the standard value of 3.35×10^8 J/m^2-year, and CEC 1.1 for the standard value of 1.6. To give certain guidelines to the succeeding design stages, it was effective to use this sort of a table at the early stage of building design.

After determining outlines of the building, building details were designed paying special attention to the environmental determinants inherent to the site. From the studies, for example exterior walls around the core portions were decided to be clad with precast concrete panels 100 mm on foam polystyrene 50 mm, and spandrels with precast concrete panels 100 mm on foam urethane 30 mm. Glazing area is 35.5 % of the exterior wall surface. Windows are composed of two different frames, of which the outer has single sliding sashes with double glazing and the inner has four-unit sliding sashes with single glazing. For the space between the frames, both vertical sides are provided with an insulated damper for admitting outside air into the interior from an outermost aluminium louver. Thus, in summer and in-between seasons the inner window is exposed to atmospheric air, thereby an overhang shade being produced.

Since the site was located at a relatively high point in the city, natural ventilation by effective use of wind was of special concern. Summer temperature has a daily variation of about 10°C, falling to 25°C or lower at night. So, to reduce cooling load in summer, it was devised to ventilate air of the above-ceiling space by admission of nocturnal outside air. For this purpose, the head of the aforesaid window space is equipped with a grille for leading air to the above-ceiling space through a ventilator. The ventilator is opened/closed from the central control room depending on wind velocity and temperature.



Plan of typical floor



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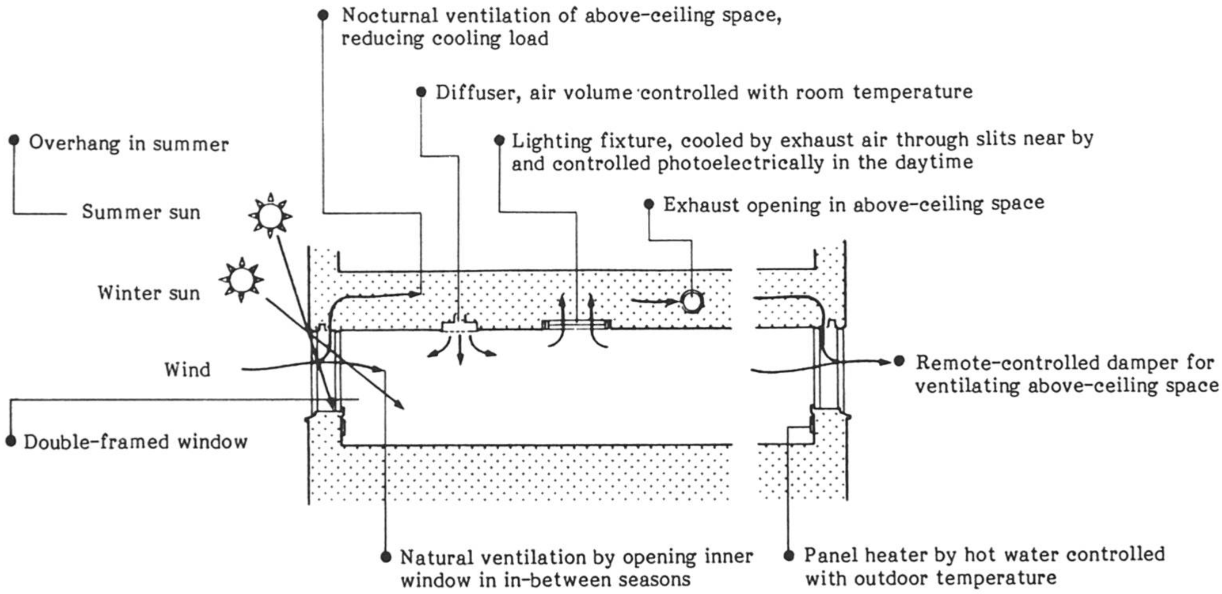

Illustration of energy-conscious office design

As previously described, this building was constructed adjoining the subway station. Therefore, another concern was to use waste heat from the station. Hot water of 45°C (2.5×10^8 J/hr) generated from the waste heat by a heat pump is used for heating the floor of entrance hall and thawing away snow on the approach to the building. In addition, to effect energy saving, domestic hot water is supplied by solar heat and waste heat from boilers for space heating, and natural lighting is fully used by photoelectrically controlling artificial lighting.

The design outside temperature is 30°C in summer and −12°C in winter. The measurement of energy consumption in 1984 showed that yearly cooling and heating loads were 6.27×10^7 J/m²-year and 1.69×10^8 J/m²-year respectively. These values are 30 to 50 % of the general energy consumption of similar buildings.

The construction cost of this building amounted to 2500-million yen, of which about 100-million yen was for the purpose of energy saving. It is estimated that the running cost of about 22-million yen per annum can be saved. Consequently, the initial cost for energy saving will be recovered in 4.5 years.

(T. Fujimoto)

$$* \quad \text{PAL} = \frac{\text{(Annual thermal load in perimeter zone)}}{\text{(Floor area of perimeter zone)}}$$

PAL is purposed to evaluate thermal characteristics of fenestration, exterior walls and shading devices.

$$\text{CEC} = \frac{\text{(Annual energy to be consumed by air-conditioning equipment)}}{\text{(Annual thermal load in perimeter zone and interior zone)}}$$

CEC is an index to energy saving effect of air-conditioning equipment.

The Energy Saving Law provides that PAL and CEC shall not exceed 3.35×10^8 J/m²-year and 1.6 respectively.