Environmental Adjustment Systems of Honda Wako Building

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ABSTRACT
" Honda Wako Building (hereinafter called HWB)" is a high efficiency saving energy office building with six floors having 52,138-m^2 of total floor area. Honda Motor Co., Ltd (hereinafter called Honda Motor) required reducing 50 % of emission of life cycle CO_2 as compared with a standard building at the design stage. To realize energy saving building, the architectural plan has two distinguishing characteristics.

Firstly, both of whole of south and north of facade consist of low-e coating glasses and aluminum panels. Secondly, HWB has the following three atriums, a south side atrium of five floors along the facade (Fig 2), a north side atrium of four floors along the facade and a center atrium of six floors (Fig 3). The two office spaces are located between three atriums. These atriums provide a thermal buffer effect against exterior environment with the distance between the office space and the windows to realize perimeter-less air-conditioning.

Moreover, high efficiency centrifugal chillers and large temperature differential system are used as energy saving systems.

The above saving energy systems got result the annual energy consumption was 15-20% less than the average of the latest office buildings with more than 40,000-m^2 of total floor area in Japan (ECCJ, 2006).

Figure 1: Exterior of HWB

1. INTRODUCTION

HWB was built as second headquarters office of Honda Motor to create "the base of creation" and actualize "co-creation" and "speed" as the keyword. Low-rise buildings are dotted in sizable plot like a suburban campus (Fig 1).

HWB has large atriums by the window using the spacious site of approximately 10 ha and has large typical floors of approximately 8,000 m^2.

To reduce CO_2 emission, following the strategies are adopted, although HWB has large area glass facade. 1) Having atriums by the window cuts off the perimeter-zone from office space practically. 2) Using low-e coating glasses reduces air-conditioning loads on the window. 3) Utilizing natural energy such as natural ventilation, daylight, and solar photovoltaic power generation.

Figure 2: South side atrium

Figure 3: Center atrium

4) Using the energy conservation equipment systems such as thermal storage air-conditioning system and high efficiency transformers.

Generally, there are two aspects of perimeter zone based on a thermal environment. One is an installation of an "air-conditioning" for perimeter zone by the HVAC service method. The other is "the perimeter-less air-conditioning" defined as preventing air-conditioning equipment for perimeter zone because of reducing solar radiation and thermal transfer load to a negligible low level.

HWB provides the atriums near the windows as thermal buffer zones, so that the office spaces are apart from the windows, to realize "no perimeter zone". Low-e coating glasses having high-grade heat insulation and heat block performance is also used for windows to reduce affects of thermal loads from the windows (Fig 2). Therefore, HWB needs no air-handling units for perimeter zone because of minimizing perimeter air-conditioning loads.

2. BUILDING PROFILE

2.1 Architecture

Name of the building	: Honda Wako Building
Location	: Wako city, Saitama PRF, Japan
Client	: Honda Motor Co., Ltd.
Design and supervision	: KUME SEKKEI Co., Ltd.
Site area	: 97,729.73 m^2
Building area	: 14,774.09 m^2
Amount floor area	: 52,138.496 m^2
Use application	: Office, cafeteria, parking
Structure	: Steel moment frame, damping structure
Number of stories	: 6 stories above the ground
Height	: 33.943 m
Contractor	
Architecture	: Takenaka Corporation
Electrical services	: Kandenko
HVAC & plumbing	: SHINRYO Corporation
Construction schedule	: From April 16th, 2003 to July 5th, 2004

2.2 Electrical system

Power receiving system	: Parallel feeder, 66 kV
	: Two extra-high voltage transformers 7,500 kVA
Contract demand	: 5,000 kW

	(Whole area of the site)
Distribution system	: Parallel feeder, 6,600V
Generator equipment	: Gas turbine, 750 kVA UPS, 160 kVA

2.3 HVAC system

Heating/cooling plant	: Two centrifugal chillers with 1,758 kW : Water thermal storage tank, 120,000 MJ (3,000 m^3), Vertical baffle type : Five once-pass boilers with 1,250 kW : Chilled water, 8 to 18 deg C : Hot water, 45 to 37 deg C
Air-conditioning system	: Single duct variable air volume system with air barrier fans

2.4 Plumbing system

Plumbing fixture	: Water saving type closets, flushing water 7 L/flush
Water supply system (Water source)	: Portable water (City water), Non-portable water (Storm water, well water), Reclaimed water (Kitchen wastewater reclaimed), Makeup water (Well water)
Hot water supply system	: Kitchen (Central), Wash basin at WC (Local)
Fire extinguishing system	: Sprinkler system, Fire hydrant system, Inert gas fire extinguishing system

3. OUTLINE AND CHARACTERISTICS OF ATRIUMS

HWB was built the low-rise blocks, so the optical and physical effect of HWB to the imminent environment. HWB reduces the environmental load, the construction and O&M cost because of the reduction of the outside wall area. The following design integrated with architectural and building service was adopted to realize good residential environment, and to minimize the energy consumption required for the environmental sustainability.

3.1 Integration architectural and equipment planning

HWB adopted the gigantic area of the typical floor that was 104 meter by 71 meter, to achieve the space where company members feel unity by gathering at the office to actualize “co-creation”. The typical floor has the following three atriums, a south side atrium of five floors along the facade, a north side of four floors along the facade and a center atrium of six floors. The office space on the typical floor is divided into two zones with the three atriums. These atriums provide a thermal buffer effect against exterior environment with the distance between the office space and the windows to realize a perimeter-less air-conditioning (Fig 4).

These atriums have the following environmental systems, the south and north glass curtain wall adopted low-e coating glasses, the automatic control blind homing in on the sun, the automatic control natural ventilation system, the floor heating and cooling, that prompt to have a cross-floor communication and contribute to build a comfortable work environment.

These atriums also create brightly and wide open office space, due to natural sunlight from the very large skylight of the center atrium, even though a planar shape of the typical floor has long distance from the windows.

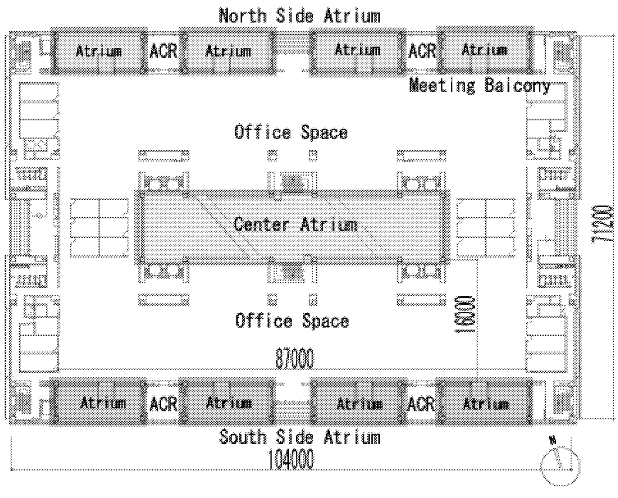

Figure 4: Typical floor plan of HWB

3.2 Realization of the environmental adjustment systems for each season

As shown in Fig.5, the thermal buffer spaces of the south and north atriums have three environmental adjustment systems. One is a discharge system of hot air near the ceiling in summer. Another is a prevention system of cold draft along the window in winter. And, the other is a natural ventilation system with remote operation and outdoor climate sensors to reduce cooling load in spring and autumn. To ensure the thermal buffer effect, airflow from linear fans installed in the floor facing south and north atriums between the office spaces and atriums block thermal affect from atriums.

*3.2.1 Summe*r

If the temperature at the top of south atrium exceeds a set value, exhaust air fans are operated to discharge hot air. The volume of reducing second and third floor return air balance the volume of discharging hot air.

3.2.2 Spring and autumn

The natural ventilation and night purge is operated to open windows of the bottom and the top of the atriums. Motorized ventilating openings are installed at the bottom of south and north atriums, and at the top of each atrium, "recommendation of natural ventilation" is displayed on the central supervisory board only when the weather condition is suitable for the natural ventilation. An operation manager decides whether to operate the natural ventilation.

3.2.3 Winter

Cold air near the window is collected from the suction openings at the bottom of the atriums before flowing office space.

Alternatively, linear fans are installed in the floor fronting south and north atriums, between office spaces and atriums, to block the thermal effect of atriums (Fig. 5).

As shown in Fig.6, there is no perimeter zone because the distance between the window and the office space is 6,400 mm and the atriums work as a thermal buffer.

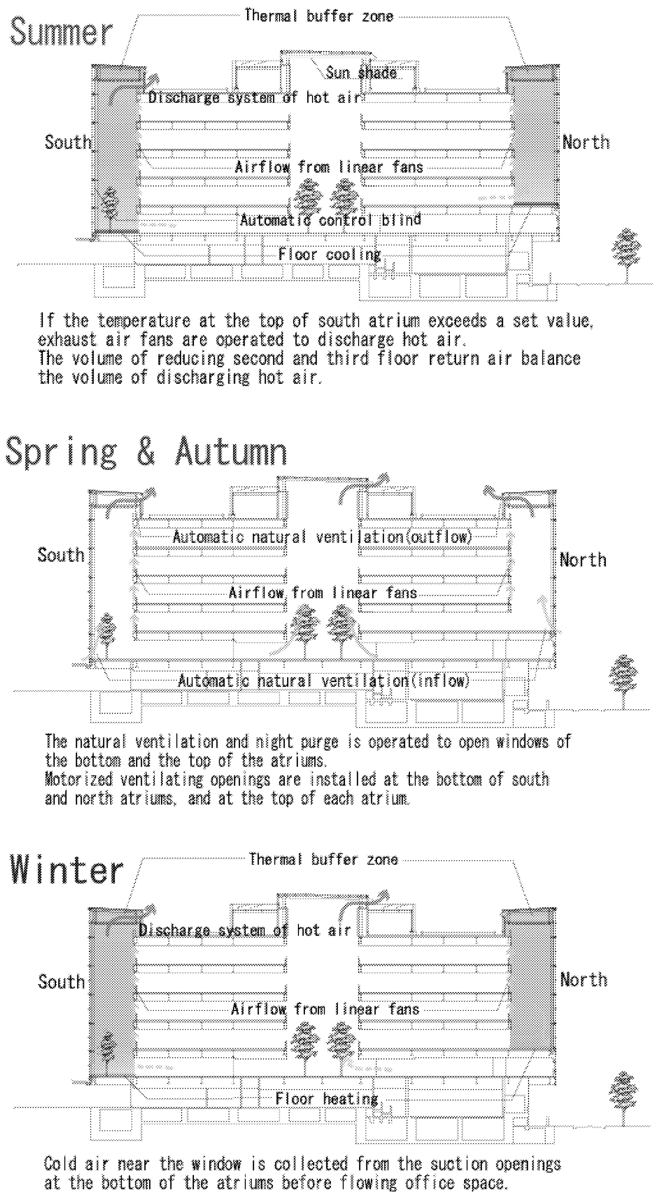

Figure 5: Environmental adjustment systems

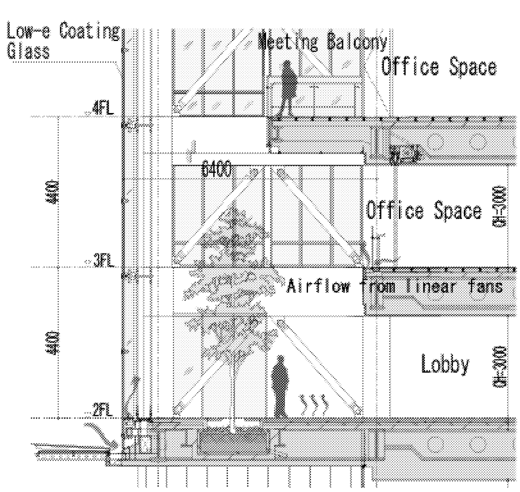

Figure 6: Section of south side atrium

3.3 Reducing air conditioning load drastically

HWB achieved reducing air conditioning load to realize the perimeter-less air-conditioning, to adopt low-e coating glasses for window of north and south side atriums, and to place atriums front onto the windows.

The calculation result of perimeter air-conditioning load in the case of using single layer clear float glasses, low-e coating glasses, and low-e coating glasses with south and north side atriums are shown in Fig.4.

Locating atriums, resting rooms, and machine rooms by the window of typical floor provides that the office spaces are apart from the windows and reduces 60 – 67% of the peak air-conditioning loads compare with not locating atriums. Additionally, using low-e glasses for the overall of north and south windows of facade reduces 22 – 24% of the peak air-conditioning loads compare to single layer clear float glasses. The perimeter of HWB reduces more than 80% of the peak air-conditioning loads compare with not locating atriums with single layer clear float glasses, therefore HWB has no air-handling units for perimeter zone and realizes perimeter-less air-conditioning (Fig 7).

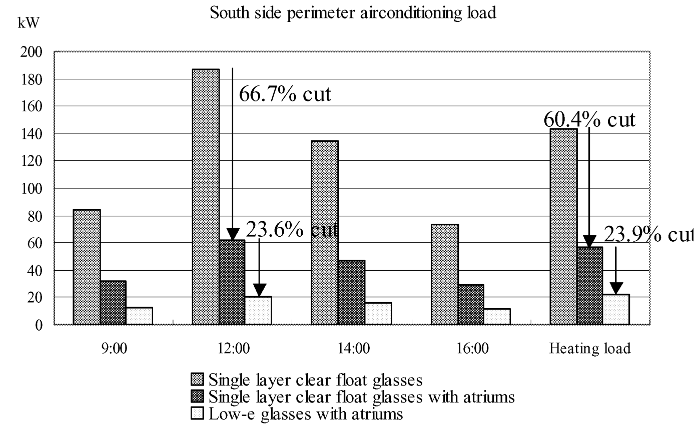

Figure 7: Air-conditioning load of perimeter

4. CONCLUSION

The decrease in CO_2 emissions at the stage of design, construction, and operation of first year was "37.8 % as compared with a standard building". A standard building as a basis for comparison was defined as "a same scale and shape building without saving energy systems adopted in HWB". The primary energy consumption for the office spaces year one performance was also 1,540 MJ/m^2/year from Mar. 2005 to Feb. 2006. Annual carbon dioxide emission from energy consumption resulted in 62.3 kg-CO_2/m^2.

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