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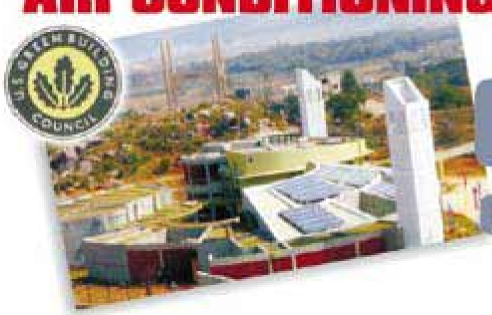
AIR CONDITIONING THE CII GODREJ GREEN BUSINESS CENTRE



By Ashish Rakheja and Dr. Prem C. Jain
Spectral Services Consultants Pvt. Ltd.
New Delhi

Ashish Rakheja graduated from MNREC, Allahabad and then earned an M. Tech. in thermal engineering from IIT Delhi.
He is visiting faculty at School of Planning & Architecture and Vastu Kala Academy in New Delhi. As a consulting engineer at Spectral Services Consultants, he has been involved in the design of building services for many projects all over the country.
He is presently president of Delhi Chapter of ISHRAE and BOG member of ASHRAE India chapter.

Dr. Prem C. Jain is the president and founder of Spectral Services Consultants and holds a doctorate in mechanical engineering from the University of Minnesota, USA. Since 1973 he teaches architectural students the science of air conditioning at the Delhi School of Planning & Architecture. With 45 years of design and consulting experience, he is the first practising engineer in India to be nominated Fellow of ASHRAE, USA.
He is the founder president of ASHRAE India chapter and is also the founder member and president emeritus of ISHRAE.

In the fast growing building construc tion industry, there are rising con cerns regarding infrastructure. Rapid and widespread mushrooming of buildings in urban areas have put considerable pressure on natural resources. Today the bulk of electricity use is in the cities and generation is not able to meet the demand. A study in Class-I Indian cities has shown that 56-68% of these cities receive less than 100 L of water supply per capita per day. Moreover, any new construction activity is carried out at the cost of depleting land and natural resources. The Green House Gas emissions contribute to global climate change. Under this threat to our fast degrading environment, the “green building practice” advocates appreciation of our natural wealth and significantly reduces or eliminates the negative impact of buildings on the environment.

Green Building Design

A green building design focuses on sustainable site planning, emphasizes on designing for the climate and promotes use of efficient materials, equipment and good construction practices. Besides, a concern for providing conducive and healthy environment for the occupants is an integral part of the design. The direct benefits of green design include resource efficiency, improved air quality (indoor and outdoor), minimal waste generation, reduced water consumption and energy efficiency. In other words, green design has environmental, economic and social elements that benefit all building stakeholders, including owners, occupants and the general public. Lastly, green building design requires involvement of all players in the development process starting from the design team (building owners, architect and engineers), construction team (material manufacturers, contractors and waste haulers), maintenance staff and building occupants.

The CII Godrej Green Business Centre

The CII Godrej Green Business Centre has been set up at Hyderabad and is a joint effort by the influential Confederation of Indian Industries and the Godrej industrial house. The building has been rated 'Platinum' by the US Green Building Council and is the third building in the world (first outside the United States of America) to achieve this distinction. It is a showcase project to educate the Indian construction industry about the benefits of going green and also usher in an era of reforms in the construction industry, where norms can be established which would make it mandatory for both building owners as well as developers, to reduce the environmental footprint of their buildings. CII-Godrej Green Business Centre has an energy-efficient air conditioning system, advanced electrical system, automatic plumbing and fire fighting systems, addressable analogue intelligent fire alarm system and security system. All these sub- systems are integrated through a state-of-the-art Building Management System.

The building has a super built area of 1700 m^2 spread over ground and first floor. On the ground floor, a large area is dedicated for a Technology Centre (Permanent Display Area), where all the strategic partners display their products which have been used on the project. In addition, the ground floor houses two Meeting Rooms, a Seminar Hall and an Information Centre. The first floor is primarily used by CII as their local office. Parking is planned around the building with designated surface car park areas.

Technical data for the "building services" systems is shown in **Table 1**.

Table 1 : Technical data for "building services" systems.

AIR CONDITIONING SYSTEM		
1. Cumulative Air conditioning load	:	:65 TR (approx 26 m^2/ton)
2. Water Chilling Machines	:	2×25 TR water-cooled Scroll chillers including provision for installing one additional machine of 25 TR in the future.
3. Pumps	:	Primary chilled water pumps. Variable speed secondary chilled water pumps. Condensing water pumps.
4. Cooling Towers	:	2×30 TR each with a large basin for extended hours of operation in case of disruption in the water supply.
5. Air Handling Units	:	6 numbers, variable volume, located on a zonal basis.
ELECTRICAL SYSTEM		
1. Peak Electrical Demand	:	125 kW (approx. 75 w/m^2)
2. Installed Transformer Capacity	:	1×200 KVA
PLUMBING SYSTEM		
1. Water Consumption	:	7,000 L per day

Design Philosophy

From inception at the drawing board stage, the emphasis in design of M&E services has been laid on the following aspects:

- Conservation of natural resources.
- Recycling of building waste.
- Environment protection.
- Energy conservation.
- Occupant comfort.
- Integrated Building Management System.
- Co-ordination of services

Design Interventions

The building has been oriented in a manner to maximize north and south exposure and minimize east and west exposures. A fine balance is achieved between fenestration and wall area to harvest maximum day light and simultaneously reduce heat gain from corridors. The selection of glazing is carried out considering its U factor, solar heat gain coefficient and visible light transmittance. The windows have extensive shading arrangement to prevent ingress of direct sunlight.

The building envelope is constructed out of aerated concrete blocks which have good thermal resistance. Part of the roof is covered with a garden which provides a thermal break as well as contributes towards greening of the environment. The balance roof has overdeck insulation (for preventing heat ingress at the source) using Polyurethane Foam. Thus, the building parameters achieved are as shown in **Table 2**.

Table 2 : Building parameters achieved.

PARAMETER	VALUE
Building envelope wall	
U-value	0.1 Btu/hr ft^2 °F
Heat capacity	13.6
Roof	
Bare roof U-value	0.052 Btu/hr ft^2 °F
Heat capacity	9.5 (without roof garden)
Roof with garden U-value	0.05 Btu/hr ft^2 °F
Heat capacity	13.0 (with roof garden)
Vertical fenestration assembly	
(Double glass)	0.3 Btu/hr ft^2 °F (U glass) in thermally
North	unbroken aluminum sections

U-assembly value	0.61
SHGC	0.3 Btu/hr ft² °F (U glass) in thermally
Other directions	unbroken aluminum sections
U-assembly value	0.45
SHGC	

Energy Modeling

For optimizing performance, computer modeling of the building was carried out using Visual DOE software. This assisted in the study of individual elements and equipment which contribute towards energy efficiency. Selection of air conditioning equipment required an interactive dialogue with modelers and manufacturers to maximize energy conservation. As a design exercise, it is mandatory (as per guidelines laid down by US Green Building Council) that a base building computer model be created using parameters defined in ASHRAE Standard 90.1 – 2001. All comparisons for optimizing operating costs are made with this base building.

The results shown in **Table 3** were achieved as part of the modeling exercise.

Table 3 : Energy modeling results.

Description	Annual Power consumption	
	Proposed Building	**Base Building**
Electricity	1,94,394 kWh (Rs. 9,71,970)	3,41,612 kWh (Rs. 17,08,060)
Solar Recovery (through photo voltaic cells)	26,500 kWh (Rs. 1,32,500)	
NET	Rs. 8,39,470	Rs. 17,08,060

Thus, 50.85% savings in energy bill are predicted over the base building.

Since the building has a solar power generation system, hence it is considered as a recovery from energy bills. The solar power generated is stored in batteries and synchronized with grid power to supply the electrical loads in the building.

HVAC System Design

The air conditioning system installation complies with following ASHRAE Standards as per design criterion stipulated by US Green Building Council:

ASHRAE Standard 129 – 1997

ASHRAE Standard 62 – 1994

ASHRAE Standard 55 – 1992 (Addendum 1995)

ASHRAE Standard 90.1 – 2001

Besides, it also complies with local regulations and the National Building Code of India.

Chiller Selection

Special emphasis is laid on selecting the most energyefficient water chilling machines as these are the largest consumer of power in an air conditioned building (nearly 25% at full load). Accordingly, two water-cooled scroll chilling machines of 25 TR capacity each have been selected with a provision of adding one 25 TR chilling machine in the future. This shortfall in chiller capacity visa- vis total installed tonnage is based on the brief that the Technology Centre and Seminar Hall will not operate simultaneously. In order to prevent accidental simultaneous operation, the Building Management System oversees the functioning of the air conditioning system.

The selected chillers have a COP of 4.45 with IPLV 5.20. All chilling machines are factory tested as per ARI conditions.

In the absence of differential power tariff and nonavailability of natural gas, options of thermal storage system as well as gas-fired absorption chilling machines were discarded.

Pump Selection Criterion

Since the load profile of the building presents a large hourly, diurnal, monthly as well as yearly variations, hence a primary-secondary zonal pumping system has been adopted. Each secondary chilled water pump is provided with variable-frequency drives to vary the chilled water flow through the cooling coil of air handling units as per demand. The pumping arrangement selected is parallel pumping with individual drive at each pump in order to increase the reliability. Operation of the pump is linked to differential pressure sensors, which are strategically located in the chilled water pipes. All pumps have been selected for efficiency exceeding 75%. been selected for efficiency exceeding 75%.

Selection of Cooling Towers

All cooling towers carry certification from Cooling Tower Institute, USA with performance in excess of 38.2 gpm/hp as per ASHRAE Standard. These selected cooling towers are induced draft type, most energy efficient among their contemporaries.

Selection of Air Handling Units

All air handling units are variable volume type of double skin construction, comprising of supply and return air centrifugal fan, each with a variable frequency drive. All AHUs are floor standing with ducted supply air and return air arrangement. Airflow in the room is varied based on occupancy and inside temperature. Continuous monitoring of carbon-dioxide level in each room is carried out and fresh air addition in the space is modulated so that the difference between indoor and outdoor CO_2 concentration does not exceed 530 ppm. This regulates fresh air intake as it is linked to the number of occupants. In addition, since fresh air quantity required for the Seminar Hall during peak occupancy is nearly 5000 cfm, a heat recovery wheel has been provided to recover energy from the exhaust air.

Pre-Cooling of Fresh Air

A unique feature of the building are two wind towers which pre-cool the fresh air. These wind towers are primarily tall hollow structures with cavity wall construction. Water is sprayed at night through the cavity wall which reduces the temperature of the thermal mass. Fresh air to all air handling units is connected at the bottom of the wind tower and air is drawn from the top. During the day time, when fresh air for air handling units is drawn through the wind tower, it comes in contact with low temperature cavity walls which helps in precooling. Since there is no direct contact between water and air, hence only sensible heat transfer is achieved without any gain in latent load.

Interior Lighting System

All lights in the space are connected to a sophisticated lighting management system to vary the intensity of artificial lights based on natural light levels. Glazing in the building is optimized using a computer simulation program to minimize the heat gain in the space. Inclined glazing has been provided in Permanent Display area, which blocks the transmission of heat but permits natural light ingress in the space. All glazed areas have been provided with hermetically sealed insulated double glass for reducing the heat gain in the space as well as for acoustical purposes. All lighting fixtures adjacent to glazing areas are linked to daylight sensors for varying the intensity of lights and to provide constant desired lux-level in the space. In addition, occupancy sensor based lighting has been provided for normally unoccupied areas like toilets and pantry.

Occupancy sensors are also provided for switching lights in all spaces to ensure that only minimum security lighting is maintained, in the absence of any occupancy. Lastly, all lights are connected to Building Management System for time scheduling. The lights are switched 'on' and 'off' at fixed time schedules with a provision of manual over-ride.

All the above measures ensure that heat gain in the space through artificial and natural lighting system is minimized, thereby significantly reducing the air conditioning load.

Conservation of Water

Total expected peak domestic water demand for the building is 7,000 L/day including make-up water at cooling towers of approximately 5,000 L/day. Since the site is spread over a large area, hence horticulture demand is met through a Root-Zone treatment plant where sewage/sullage from the building is treated and re-cycled for horticulture.

Environment Protection

A conscious effort has been made to ensure that installed services make a positive contribution to the environment and exceed local pollution control norms. Use of HFC refrigerant, scrubbing of combustion flue, recycling of waste, use of energy-efficient motors, employing variable frequency drives, optimum lighting levels in occupied areas, etc. are some of the measures which have been considered from the concept design stage. In addition, various parameters like combustion flue emission levels, air quality, power factor etc. including equipment performance are constantly monitored through the Building Management System.

Fire Safety

The highest fire safety norms in accordance with NFPA and local codes have been followed. State-of-the- art microprocessor based addressable Fire Alarm System has been provided. Since the building does not require any sprinkler system (as per National Building Code), hence all the main electrical panels in the building have resident aerosol gas canisters interlocked through a fire alarm system, which can automatically operate in case of any emergency. Lastly, the health of the fire safety system is constantly monitored through the Building Management System.

Integrated Building Automation System

Various services in the building have been integrated into a Building Management System for cohesive and reliable operation. A combination of both “surface integration” and “in-depth integration” has been carried out depending on the application.

Conclusion

With the rapid decline in environment and degradation of natural resources, use of green building practices provides an effective way of checking misuse and promote concept of energy-efficient buildings. No doubt that green architecture requires additional efforts as well as capital cost on the part of the developer, however, in the long run, payback is achieved in the initial few years and thereafter benefits accrued are both monetary as well as help in reducing harmful effects on the built environment.

Project Team

Client : Confederation of Indian Industries (CII)
Architect : Karan Grover and Associates
Commissioning Agent : C.R. Narayan Rao
Energy Management Consultant : The Energy and Resources Institute (TERI)
Landscaping Consultant : Aarti Chari and Associates
Services Consultant : Spectral Services Consultants Pvt. Ltd.