# Energy Conservation Building Code

## COMPLIANT BUILDINGS

Bureau of Energy Efficiency

*Prepared for*

*Published by*

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## INTRODUCTION

The Government of India enacted the Energy Conservation Act in August 2001. The BEE (Bureau of Energy Efficiency) was created as a statutory body to implement the act. The act empowers the government to prescribe the ECBC (Energy Conservation Building Code) for efficient use of energy and its conservation in buildings or building complexes. The ECBC sets minimum energy performance standards for the design and construction of non-residential buildings. It encourages energy efficient building systems such as building envelopes, lighting, HVAC (heating, ventilation, and air-conditioning), service water heating, and electric power distribution within the building facilities, while enhancing the comfort and productivity of the occupants. The ECBC will be applicable to all buildings with a demand in excess of 500 kW, or connected load in excess of 600 kVA.

The ECBC has been in discussion with various stakeholders. Some of the organizations have already adopted this code. This booklet seeks to highlight a few case studies of buildings that comply with the ECBC. The studies conducted on these buildings illustrate energy savings that ECBC underwrites. The booklet is a part of the information dissemination measures needed to propagate adoption of the ECBC.

# CASE STUDY Centre for Environmental Sciences and Engineering building, Indian Institute of Technology, Kanpur

Client: Indian Institute of Technology, Kanpur
Architect: Kanvinde Rai and Chowdhury Architects and Planners
Energy consultant: TERI (The Energy and Resources Institute)
HVAC* consultant: Gupta Consultants and Associates
Electrical consultant: Kanwar Krishen Associates Pvt. Ltd
Status: Under construction, to be completed in December, 2007
Schedule of operation: Day use building, five days per week

## Brief description

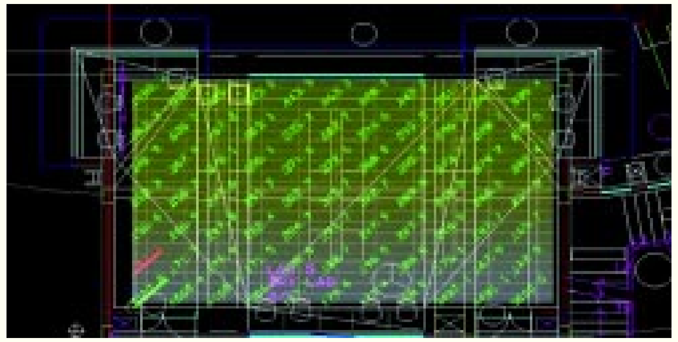
The CESE (Centre for Environmental Sciences and Engineering ) building is a research facility at the IIT (Indian Institute of Technology), Kanpur on a plot area of 175 000 sq mts (approximately 4.5 acres). The facility houses laboratories, seminar rooms, and discussion rooms for various disciplines of environmental sciences. Given the function of the building, it was decided that it should be designed in an environment friendly manner. The building is undergoing TERI-GRIHA (Green Rating for Integrated Habitat Assessment) rating and is thus compliant with the ECBC (Energy Conservation Building Code). The building has incorporated many green features following TERI-GRIHA recommendations. These features are integrated in sustainable site planning to maintain favourable microclimate around the building. The architectural design has been optimized as per climate and sun path analysis. Passive strategies such as an earth air tunnel have been incorporated in the air handling units to reduce the cooling load.

## Energy efficiency and green features in the building

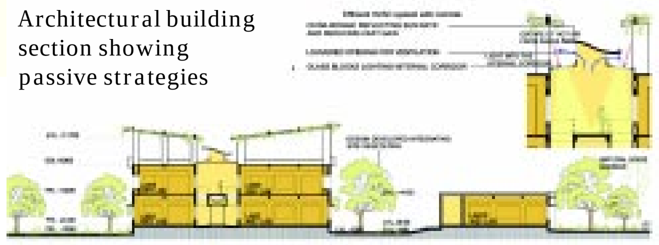
The building's green design features include the following.

- The site for the building has full-grown mature trees, most of which were protected and preserved.
- The building is fully compliant with the ECBC.
- Solar passive architectural design strategies are adopted and all the laboratory spaces would be naturally lit during the day time.
- Rain water harvesting is done and treated waste water is reused for irrigation.

Lighting simulation carried out to integrate daylight with artificial lighting



Architectural building section showing passive strategies



* Heating, ventilation, and air conditioning

## Building performance on compliance with the Energy Conservation Building Code

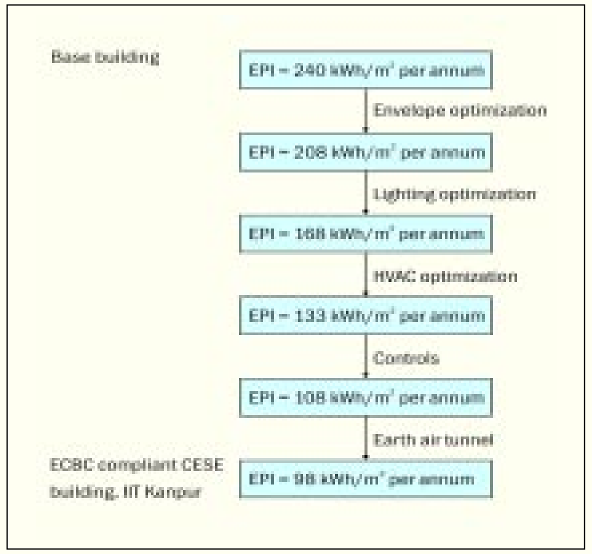
Following the recommendations of the ECBC of the Bureau of Energy Efficiency, Government of India, several energy efficient strategies have been adopted in the CESE building. This section compares a base building with the ECBC building.

| | Base building | CESE building, IIT Kanpur |
|---|---|---|
| | **1. Building envelope** | |
| External wall | 230 mm brick work plastered on both sides<br>U-value = 1.985 W/m²K | External finish + 115 mm brick wall + 50 mm expanded polystyrene insulation + 115 mm brick wall + internal plaster<br>U-value = 0.51 W/m²K |
| Roof | 150 mm concrete roof slab + 100 mm brick coba + roof tiles finish<br>U-value = 2.43 W/m²K | 150mm concrete roof slab + 50 mm fibre glass insulation + 100 mm brick coba + roof tiles finish<br>U-value = 0.56 W/m²K |
| Glass | Single clear 6 mm glass<br>U-value = 5.7 W/m²K<br>SHGC = 0.85<br>Light transmittance = 89% | Double glazed low emissivity glass<br>U-value = 1.6 W/m²K<br>SHGC = 0.40<br>External shading designed to reduce SHGC to 0.25<br>Light transmittance = 62% |
| | EPI = 240 kWh/m² per annum | EPI = 208 kWh /m² per annum (10% reduction)after building envelope optimization |
| | **2. Lighting** | |
| | LPD = 20 W/m² | LPD achieved is less than 10 W/m²<br>T5 tube lights and CFLs have been used |
| | EPI = 240 kWh/m² per annum | EPI = 168 kWh /m² per annum (30% reduction)after building envelope + lighting optimization |
| | **3. HVAC** | |
| | Chiller efficiency = 1.21 KW/TR | Chiller efficiency = 0.74 KW/TR<br>Water cooled screw chiller has been used |
| | EPI = 240 kWh/m² per annum | EPI = 133 kWh /m² per annum (45% reduction)after building envelope + lighting + HVAC optimization |
| | **4. Controls** | |
| | None | Integration of earth air tunnel with HVAC and daylight controls with artificial lighting |
| | EPI = 240 kWh/m² per annum | EPI = 108 kWh /m² per annum (54% reduction) after building envelope + lighting + HVAC optimization + controls + EAT |
| | **5. Integration of passive strategy** | |
| | None | Integration of EAT with HVAC |
| | EPI = 240 kWh/m² per annum | EPI = 98 kWh /m² per annum (58% reduction) after building envelope + lighting + HVAC optimization + controls + EAT |

CFL – compact fluorescent lamps; EAT – earth air tunnel; EPI – Energy Performance Index; HVAC – heating, ventilation, and air – conditioning; LPD – light power density; SHGC – solar heat gain coefficient

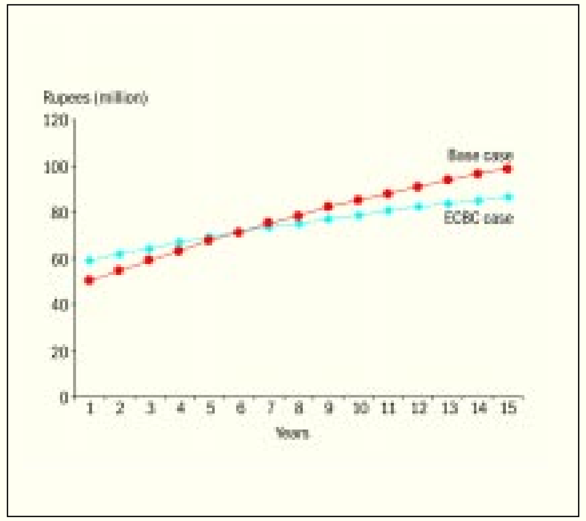
*EPI includes lighting and cooling electricity consumption only*

Energy savings achieved through ECBC interventions




### Life cycle cost analysis

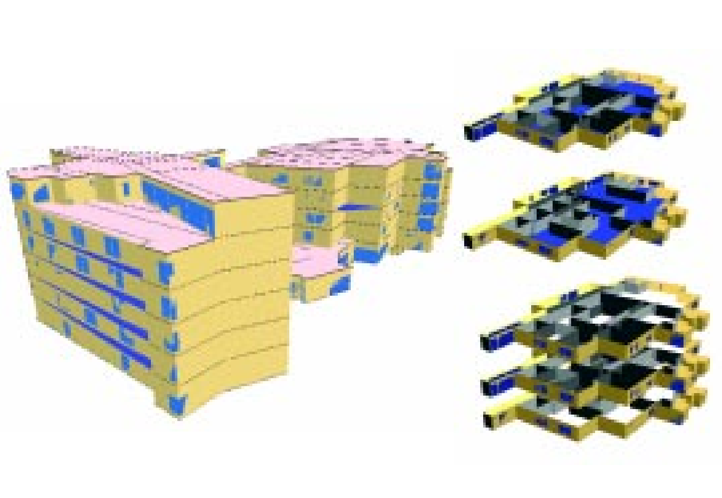
The ECBC compliant building entails an initial incremental cost of 20% as compared to the base building, with a payback period of 5–6 years. As shown in the chart, net savings in total cost are estimated to be 15% in 15 years of the CESE building.



CASE STUDY

# Fortis hospital building, Shalimarbagh, New Delhi

Client: Fortis Healthcare Ltd
Architect: Mani Chowfla Associates
Energy Consultant: TERI (The Energy and Resources Institute)
HVAC* consultant: Dewpoint Consultants, Design Engineering Partners
Electrical Consultant: T S Sethi, Design Engineering Partners
Status: Construction expected to begin in June 2007
Schedule of operation: 24-hours building

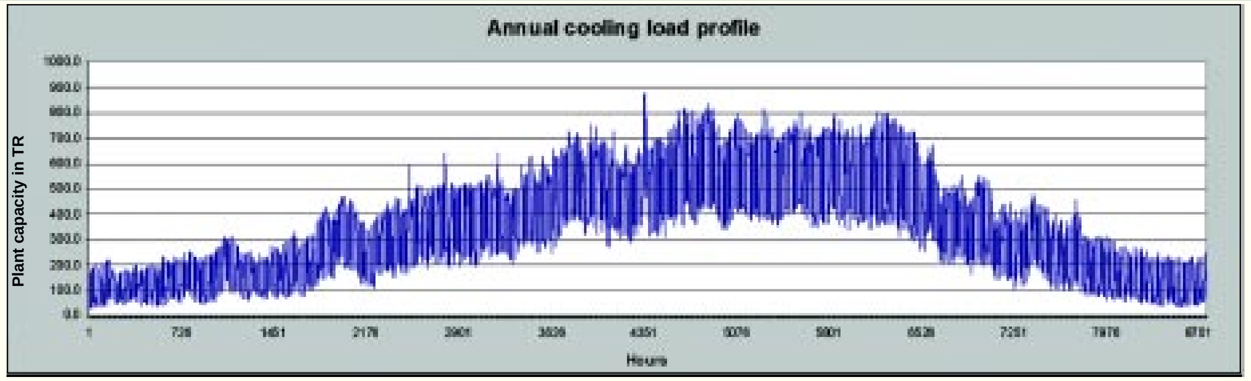


## Brief description

The Fortis hospital at Shalimarbagh, New Delhi, is being designed with a vision to provide an environment friendly health care facility. The hospital has been planned as a 500-bed facility that would cover a built up area of 64 400 sq mts, comprising cardiology, renal, and gastro intestinal units. Energy efficiency and resource conservation measures will be incorporated in various aspects of the design, construction, and operation of the proposed green building. The hospital is being designed as an energy efficient building that complies with the ECBC (Energy Conservation Building Code) and is undergoing TERI-GRIHA (Green Rating for Integrated Habitat Assessment) rating certification. It is the first hospital building in India to have registered for the building rating system.

## Energy efficiency and green features in the building

- Sustainable site planning is practiced on site to conserve resources, minimize disruption of the natural ecosystem, and maintain the microclimate of the site.
- The building design has been optimized to reduce the external solar gains and avoid over design of lighting and air-conditioning systems.
- The building would comply with the ECBC.
- Low embodied energy material options are being explored by Fortis management.
- As a commitment to control ozone-depleting substances in the atmosphere, the Fortis hospital would install CFC (chlorofluorocarbon) and HCFC (hydro chlorofluorocarbons)-free equipment for the refrigeration and air conditioning systems.




* Heating, ventilation, and air-conditioning

## Building performance on compliance with the Energy Conservation Building Code

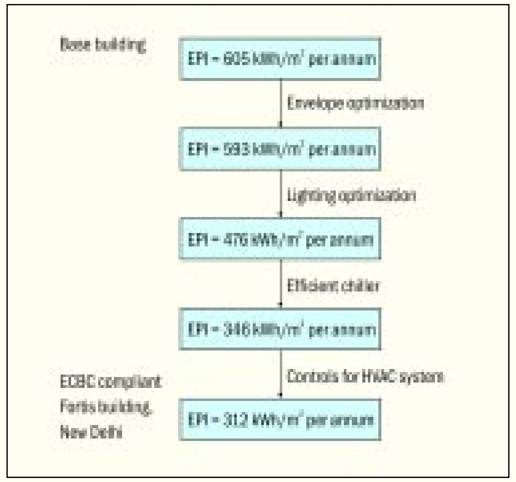
Following the recommendations of the ECBC of the Bureau of Energy Efficiency, Government of India, several energy efficiency strategies have been adopted at the Fortis hospital. This section compares a base building with the ECBC compliant building.

| | Base building | Fortis hospital, Delhi |
|---|---|---|
| | **1. Building envelope** | |
| External wall | 230 mm brick work plastered on both sides<br>U-value = 1.98 W/m²K | Cement plaster + 200 mm AAC blocks + cement plaster<br>U-value = 0.69 W/m²K |
| Roof | 150 mm concrete roof slab + 100 mm brick coba + roof tile finish<br>U-value = 2.43 W/m²K | 150 mm RCC + 65 mm vermiculite + 100 mm brick coba + 25 mm tiles<br>U-value = 0.98 W/m²K |
| Glass | Single clear 6mm glass<br>U-value = 5.7 W/m²K<br>SHGC = 0.85<br>Light transmittance = 89% | Double glazed low emissivity glass<br>U-value = 2.8 W/m²K<br>SHGC = 0.46<br>External shading designed to reduce SHGC to 0.25<br>Light transmittance = 46% |
| | EPI = 605 kWh/m² per annum | EPI = 593 kWh /m² per annum (2% reduction) after building envelope optimization |
| | **2. Lighting** | |
| | LPD = 20 W/m². | LPD achieved is less than 10 W/m² Energy efficient fixtures and lamps have been used |
| | EPI = 605 kWh/m² per annum | EPI = 476 kWh /m² per annum (21% reduction) after building envelope + lighting optimization |
| | **3. HVAC** | |
| | Chiller efficiency = 1.15 KW/TR<br>Air cooled chiller | Chiller efficiency = 0.61 KW/TR<br>Water cooled screw chiller has been used |
| | EPI = 605 kWh/m² per annum | EPI = 346 kWh /m² per annum (43% reduction) after building envelope + lighting + efficient chiller as per ECBC |
| | **4. Controls for HVAC system** | |
| | None | Variable frequency drive on chilled water pumps, air handling units |
| | EPI = 605 kWh/m² per annum | EPI = 312 kWh /m² per annum (48% reduction) after building envelope + lighting + HVAC optimization + controls |

AAC – autoclaved aerated concrete; ECBC – Energy Conservation Building Code; EPI – Energy Performance Index; HVAC – heating, ventilation, and air-conditioning; LPD – lighting power density; RCC – reinforced cement concrete; SHGC – solar heat gain coefficient

*EPI includes lighting and cooling electricity consumption only*

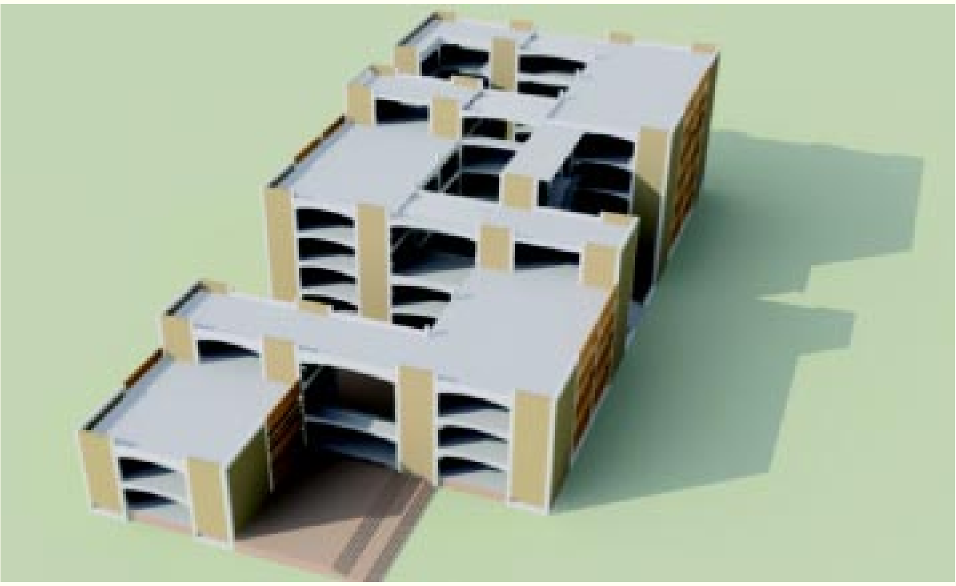
Energy savings achieved through ECBC interventions




Lighting simulations carried out to integrate daylight with artificial lighting

# CASE STUDY Triburg headquarters building, Gurgaon

Client: Triburg headquarters building, Udyog Vihar, Gurgaon
Architect: SPA Design Pvt. Ltd, New Delhi
Energy consultant: TERI (The Energy and Resources Institute)
HVAC* consultant: Engineering Services Consultants, New Delhi
Electrical consultant: Engineering Services Consultants, New Delhi
Status: Under construction
Schedule of operation: Day use building, five days per week



## Brief description

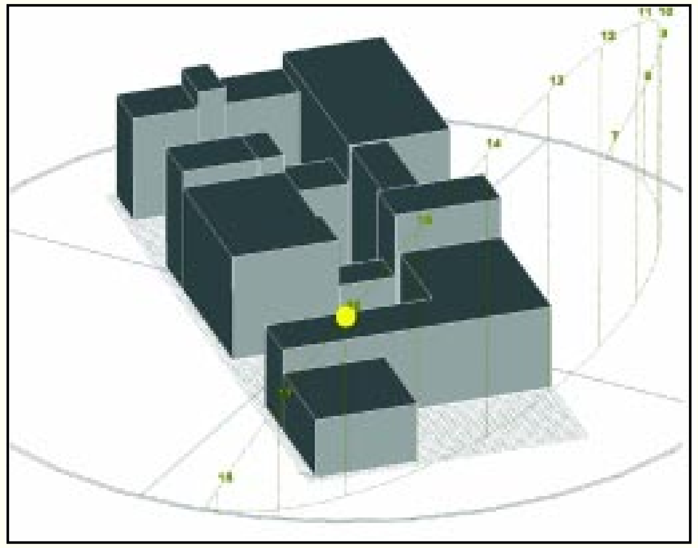
The site for the proposed Triburg headquarters building is located in the industrial area of Udyog Vihar in Gurgaon. The plot area is 7800 $m^2$ with a proposed built-up area of 10 000 $m^2$ for the superstructure and 4500 $m^2$ for the basement. The office building would incorporate various sustainable measures recommended by TERI-GRIHA (Green Rating for Integrated Habitat Assessment). The building is planned around courtyards in such a way that it increases gradually from one to four storeys towards the back of the building. The four courtyards give daylight to the offices and also increase green cover. Roof gardens are planned to add to the green area and improve the microclimate of the site. Cavity walls and insulation for exterior walls would reduce the air-conditioning requirement of the building. Efficient lighting and air-conditioning systems are planned so as to reduce the overall energy consumption of the building.

## Energy efficiency and green features in the building

Some of the green features incorporated in the design of the building include the following.

- Efficient design of the building, allowing daylight into most of the office spaces
- Efficient building envelope, resulting in reduction of cooling load in the building
- Efficient lighting system, resulting in direct energy savings, as well as reduction in cooling load

Triburg office building, with reference to sun path of Gurgaon on 1 March



## Building performance on compliance with the Energy Conservation Building Code

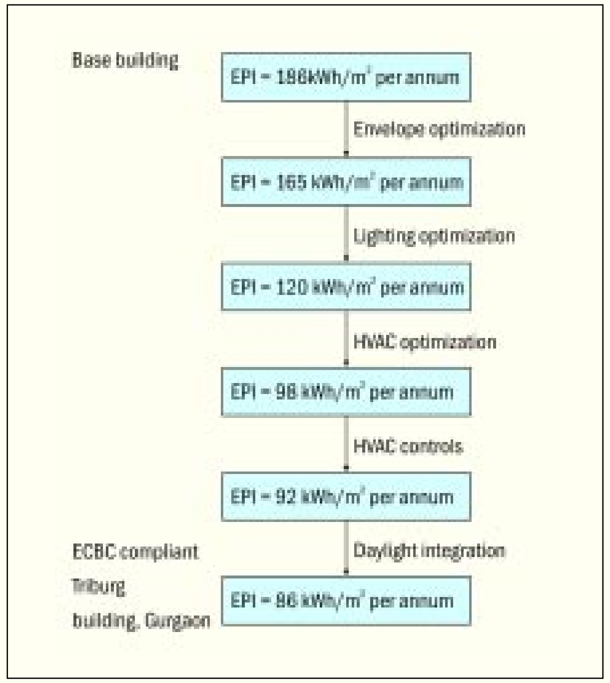
Following the recommendations of the ECBC of the Bureau of Energy Efficiency, Government of India, several energy efficiency strategies have been adopted at the Triburg headquarters building, Gurgaon. This section compares a base building with the ECBC compliant building.

| | Base building | Triburg headquarters building |
|---|---|---|
| **1. Building envelope** | | |
| External wall | 230 mm brick work plastered on both sides<br>U-value = 1.98 $W/m^2K$ | 115 mm brick wall + 230 mm air gap + 50 mm extruded polystyrene insulation + 115 mm brick wall+ internal plaster<br>U-value = 0.39 $W/m^2K$ |
| Roof | 150 mm concrete roof slab + 100 mm brick coba + roof tiles finish<br>U-value = 2.43 $W/m^2K$ | 150 mm concrete roof slab + 100 mm perlite + 75 mm round pebbles + 200 mm sweet earth<br>U-value = 0.33 $W/m^2K$ |
| Glass | Single clear 6 mm glass<br>U-value = 5.7 $W/m^2K$<br>SHGC = 0.85<br>Light transmittance =89 % | Double glazed low emissivity glass<br>U-value = 1.6 $W/m^2K$<br>SHGC = 0.57<br>External shading designed to reduce SHGC to 0.25<br>Light transmittance = 75% |
| | EPI = 186 $kWh/m^2$ per annum | EPI = 165 kWh /$m^2$ per annum (12% reduction) after building envelope optimization |
| **2. Lighting** | | |
| | LPD = 20 $W/m^2$. | LPD achieved is less than 10 $W/m^2$<br>Energy efficient fixtures and lamps have been used |
| | EPI = 186 $kWh/m^2$ per annum | EPI = 120 kWh /$m^2$ per annum (36% reduction) after building envelope + lighting optimization |
| **3. HVAC** | | |
| | Chiller efficiency = 1.15 KW/TR<br>Air cooled chiller | Chiller efficiency = 0.65 KW/TR<br>Water cooled screw chiller (150300 TR) has been used |
| | EPI = 186 $kWh/m^2$ per annum | EPI = 98 kWh /$m^2$ per annum (47% reduction) after building envelope + lighting + efficient chiller as per ECBC |
| **4. Controls for HVAC systems** | | |
| | None | Variable frequency drive on chilled water pumps, air handling units |
| | EPI = 186 $kWh/m^2$ per annum | EPI = 92 kWh /$m^2$ per annum (50% reduction) after building envelope + lighting + HVAC optimization + controls |
| **5. Daylight integration for lighting system** | | |
| | None | Daylight controls were defined to enhance energy efficiency of lighting system |
| | EPI = 186 $kWh/m^2$ per annum | EPI = 86 kWh /$m^2$ per annum (54% reduction) after building envelope + lighting + HVAC optimization + daylight controls |

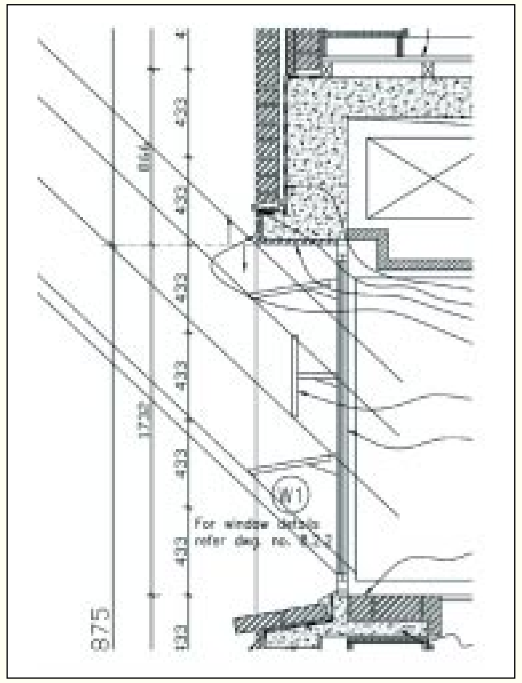
ECBC – Energy Conservation Building Code; EPI – Energy Performance Index; HVAC – heating, ventilation, and air-conditioning; LPD – lighting power density; SHGC – solar heat gain coefficient

*EPI includes lighting and cooling electricity consumption only*

Energy savings achieved through ECBC interventions




External wall cross-section, Triburg headquarters building





* Heating, ventilation, and air conditioning