10. ENERGY CONSERVATION IN BUILDINGS AND ECBC

About ECBC, Building envelope, Fenestrations, Insulation, HVAC, Lighting, Water pumping, Inverters and energy storage / captive generation, Elevators and escalators, Star labeling for existing buildings.

10.1 Introduction

There are several different uses of energy in buildings. The major uses are for lighting, heating, cooling, power delivery to equipment and appliances, and domestic water. The amount that each contributes to the total energy use varies according to the climate, type of building, number of working hours and time of year. Energy use for air-conditioning has the largest share at a national level. In areas where severe winters occur, heating load will be greater than cooling load in terms of the total energy use. In some types of buildings in certain climatic zones, the lighting load might be greater than either the heating or cooling loads.

Industrial and commercial buildings are dissimilar in terms of energy use, as industries primarily use large quantities of energy for specialized processes whereas buildings use the major amount of energy for human comfort. It is difficult to generalize energy use by type of building because there are many variables that determine the energy use in a particular building.

10.2 Building Definition as in the Energy Conservation (amendment) Act 2010

"building" means any structure or erection or part of structure or erection after the rules relating to energy conservation building codes have been notified under clause (*p*) of section 14 and clause (*a*) of section 15 and includes any existing structure or erection or part of structure or erection, which is having a connected load of 100 Kilowatt (kW) or contract demand of 120 Kilovolt Ampere (kVA) and above and is used or intended to be used for commercial purposes.

10.3 Energy Conservation Building Code (ECBC)

Energy Conservation Building Code defines the minimum energy efficiency standards for design and construction of commercial buildings, to encourage energy efficient design or major retrofit of buildings without any compromise with the building function, comfort, health, or the productivity of the occupants.

In order to implement ECBC across the country, India has been divided into five climatic zones as per the weather conditions (Figure 10.1). The Five Climatic zones are:

- Composite
- Hot Dry

- Warm Humid
- Moderate
- Cold

The ECBC Building Code considers the following aspects of the Buildings:

a) Building envelopes, except for unconditioned storage spaces or warehouses,

b) Mechanical systems and equipment, including heating, ventilation, and air conditioning,

c) Service hot water heating,

d) Interior and exterior lighting, and

e) Electrical power and motors.

The provisions of this ECBC code do not apply to:

a) Buildings that do not use either electricity or fossil fuel,

b) Equipment and portions of building systems that use energy primarily for manufacturing processes, and

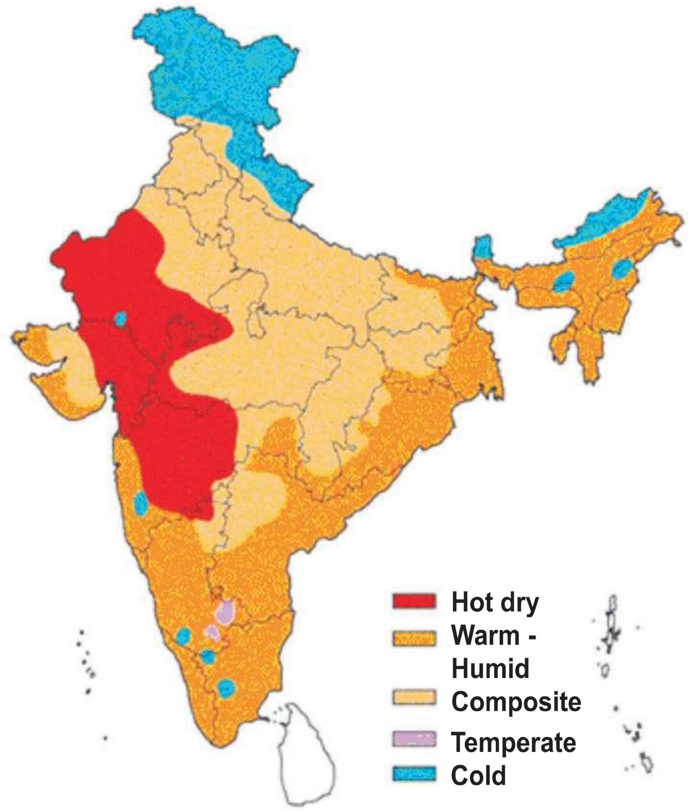

Figure 10.1 Five Climatic Zones as per the Weather Conditions

10.4 Compliance Approaches

The Code requires that the building shall comply first with all the mandatory provisions discussed in Chapter 4 to 8 (of the Code). But every building project is different: each building has its own site that presents unique opportunities and challenges, each building owner or user has different requirements, and climate and microclimate conditions can vary significantly among projects. Architects and engineers need flexibility in order to design buildings that address these diverse requirements. The Code provides this flexibility in a number of ways. Building components and systems have multiple options to comply with the Code requirements. To use the building envelope section as an example, designers can choose the Prescriptive Method that requires roof insulation be installed with a minimum R-value. Alternatively, the other options allow the designer to show compliance with the thermal performance (U-factor) of roof construction assembly. In addition building envelope tradeoff option discussed in Chapter 4 permits trade-offs among building envelope components (roof, walls, and fenestration) for Code compliance. If more flexibility is needed, the Whole Building Performance (WBP) Method approach may be used, but WBP requires simulation expertise.

a. Prescriptive Method

The Code specifies a set of prescriptive requirements for building systems and components. Compliance with the Code can be achieved by meeting or exceeding the specific levels described for each individual element of the building systems, covered in Chapter 4 through Chapter 8 of the Code. For building envelope, the Code provides a Trade-Off option that allows trading off the efficiency of one envelope element with another to achieve the overall efficiency level required by the Code. The envelope trade-off option is discussed in Chapter 12: Appendix D of ECBC.

b. Whole Building Performance Method

Use of energy simulation software is necessary to show ECBC compliance via the Whole Building Performance Method. Energy simulation is a computer-based analytical process that helps building owners and designers to evaluate the energy performance of a building and make it more energy-efficient by making necessary modifications in the design before the building is constructed.

These computer-based energy simulation programs model the thermal, visual, ventilation, and other energy consuming processes taking place within the building to predict its energy performance. The simulation program takes into account the building geometry and orientation, building materials, building façade design and characteristics, climate, indoor environmental conditions, occupant activities and schedules, HVAC and lighting system and other parameters to analyze and predict the energy performance of the building. Computer simulation of energy use can be accomplished with a variety of computer software tools and in many cases may be the best method for guiding a building project to be energy-efficient. However, this approach does require considerable knowledge of building simulation tools and very close communication between members of the design team.

Appendix B of the Code describes the Whole Building Performance Method for complying with the Code. This method involves developing a computer model of the Proposed Design and comparing its energy consumption to the Standard Design for that building. Energy consumption in the Standard Design represents the upper limit of energy use allowed for that particular building under a scenario where all the prescriptive requirements of the Code are adopted. Code compliance will be achieved if the energy use in Proposed Design is no greater than the energy used in the Standard Design.

Three basic steps are involved:

1. Design the building with energy efficiency measures; the prescriptive approach requirements provide a good starting point for the development of the design.
2. Demonstrate that the building complies with the mandatory measures.
3. Using approved simulation software, model the energy consumption of the building using the proposed features to create the Proposed Design. The model will also automatically calculate the energy use for the Proposed Design.

If the energy use in Proposed Design is lesser than the energy use in the Standard Design, the building complies with the Code.

10.5 ECBC Guidelines on Building Envelope

The building envelope refers to the exterior façade, and is comprised of walls, windows, roof, skylights, doors, and other openings. The envelope protects the building's interior and occupants from the weather conditions and other external elements. The design features of the envelope strongly affect the visual and thermal comfort of the occupants, as well as energy consumption in the building.

Building Envelope

The Exterior and semi-exterior portions in the context of defining as building envelope include:

- Elements that separate the conditioned spaces from the weather conditions, or
- Elements of a building that separate the conditioned spaces of the building from the unconditioned spaces, i.e. office space from unconditioned storage.

Building Envelope Sealing

The following areas of the enclosed building envelope shall be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

a) Joints around fenestration and door frames,

b) Openings between walls and foundations and between walls and roof and wall panels,

c) Openings at penetrations of utility services through, roofs, walls, and floors

d) Site-built fenestration and doors,

e) Building assemblies used as ducts or plenums, and

f) All other openings in the building envelope.

Envelope design Basics

From an energy efficiency point of view, the envelope design must take into consideration both the external and internal heat loads, as well as day lighting benefits. External loads include mainly solar heat gains through windows, heat losses across the envelope surfaces, and infiltration in the building. Internal loads include heat gain from electric lighting systems, equipment, and people working in the building.

One of the goals of the envelope design should be to introduce day lighting into the interior space of the building through windows and skylights, thereby reducing the need for electric lighting. Thus, giving proper orientation to the building and due consideration to the size and placement of windows at the design stage can provide the advantage of day lighting.

Secondly, to maintain thermal comfort and minimize internal cooling / heating loads, the building envelope needs to regulate and optimize heat transfer through roof, walls, windows, skylights, doors and other openings. Effective insulation of roof and walls, appropriate selection of glazing and framing for windows, and suitable shading strategy are important in designing energy efficient buildings.

Passive Solar Design Strategy

Architects should pay attention to the following basic design elements in an effort to reduce the energy consumption in small commercial buildings that can be operated without Central HVAC System.

Siting and Orientation

In a predominantly hot climate, cooling load affects the total energy consumption in commercial buildings in a significant manner. Thus, controlling heat transfer through the roof, walls, and windows becomes of utmost importance and needs to be considered from the initial stages of design. Therefore, site planners and designers should properly orient buildings to minimize solar gains in the summer.

Plot lines and roads should be situated to minimize building exposure to the east and west. These orientations provide the highest solar heat gains. Subdivisions should be planned so that the longer sides of the buildings face north and south. With proper planning, there may be no added costs for good orientation.

Shade

Use different shading strategies to minimize solar heat gain and reduce glare inside buildings. Provide vertical louvers on east and west side and horizontal shading devices on south side.

Cross-Ventilation

Building envelope should allow the movement of breeze throughout the building.

Cool Roof

This refers to the property of roof that describes its ability to reflect and reject heat. Cool roof (Figure 10.2) surfaces have both high solar reflectance and a high emittance (reject heat back to the environment).

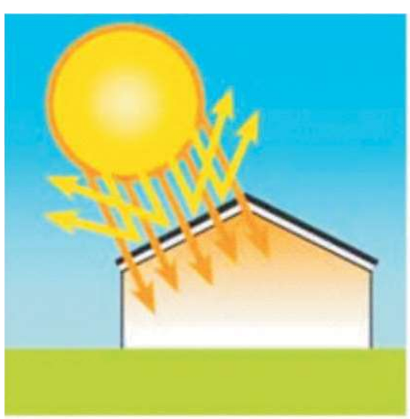

Figure 10.2 (a) Conventional Roof **(b) Cool Roof**