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Energy Optimization of Building Using Design Builder Software

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***Abstract*— The infrastructure industry is growing at the rate of 12.5%. The development of new infrastructure results in the increase of energy consumption, in particular electrical power consumption. The real estate, infrastructure growth in field of IT parks, hospitals and institutional buildings is the prime need of developing country. In order to minimize the energy consumption, there is a lot of initiatives taken by various institutions so that the newly constructed buildings should take into consideration the electrical consumption of buildings.**

The energy consumption can be reduced at the design stage by using the knowledge of climatology, solar engineering etc. In order to estimate the energy consumption of a building, energy consumption is analyzed using various methods. In this work the efforts are made to understand how to assess the energy consumption of a commercial buildings.

The software design built is used as a tool to assess and analyze the energy consumption of buildings. The software is used to quantify the architectural design concept to assess the energy consumption and the design can be modified to further reduce the energy consumption.

***Index Terms*- solar engineering, energy consumption.**

I. INTRODUCTION

India is one of the largest growing economies in the world with economic growth rate of 8.9%. Commensurate with economic growth, urbanization in India is growing fast. The construction sector in India is witnessing a fast growth due to several factors. Some of the key growth drivers are increased demand for housing, strong demographic impetus, expansion of organized retail, increased demand for commercial office spaces by multinationals and IT (information technology) hubs, and coming up of SEZs (special economic zones). The gross built-up area added to commercial and residential spaces was about 40.8 million square metres in 2008/09, which is about 1% of annual average floor area around the world, and the trend shows a sustained growth of 10% over the coming years. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, energy consumption in buildings has seen an increase from a low of 14% in the 1970s to nearly 33% in 2014/15. This is directly related to higher greenhouse gas emissions. Thus, it is the need of the hour to design and construct energy efficient buildings.

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Energy efficiency means using less energy for heating, cooling, and lighting. It also means incorporating different methods to ensure that energy is conserved. Energy-efficiency applies to everything from the building envelope, which includes energy efficient windows, insulation, foundation, and the roof, to appliances, lights, and air-conditioning systems. It also applies to space heating and cooling systems, which are aided through the use of automated controls, ventilation, improved duct systems, and other advanced technologies. Energy efficiency can also apply to water heating when combined with water-efficient appliances and fixtures that will save water, energy, and money. The building envelope includes everything that separates the interior of a building from the outdoor environment, including the windows, walls, foundation, basement slab, ceiling, roof, and insulation.

The concept of "energy efficient" buildings has immediate implications on regulations, economics, energy demand, and the environment. A definition is also needed to compare building energy performance or to assess absolute energy efficiency criteria for an energy efficient building:

- The building must be equipped with efficient equipment and materials appropriate for the location and conditions;
- The building must provide amenities and services appropriate to the building's intended use; and
- The building must be operated in such a manner as to have a low energy use compared to other, similar buildings.

An efficient building must, at a minimum, be above average in all three aspects. When setting minimum efficiency standards, a definition of energy efficiency based on minimum life cycle costs is likely to result in much stricter standards—and greater energy savings—than a strategy based on eliminating the least efficient units.

Objective

- To evaluate the energy efficiency of building using simulation software(Design Builder) with respect to ECBC standards, by placing the building in different

orientations and by varying envelope material percentage
- To find the requirement of energy efficiency in commercial building by design builder software
- Improve energy efficiency of commertial building by using energy conservation building code (ECBC) and national building code (NBC)
- Selecting building material in accordance with ECBC

METHODOLOGY

- The selection methodology involves establishing:
- Study of simulation software i.e Desingn builder
- Studying the requirement of energy conservation in commercial building
- Analysis of a commercial building as a case study
- Analysis of the building with respect to parameters deciding energy consumption

II. SCOPE OF WORK

Dissertation work attempts to determine whether a given building is Energy Efficient or inefficient. A sample commercial building project has been considered for the analysis. The energy consumption of the building will be evaluated using simulation software. The results will be compared with ECBC standards. The inference is based on the comparison.

Energy Conservation Building Code (ECBC)

The Energy Conservation Building Code (ECBC) is a document that specifies the energy performance requirements for all commercial buildings that are to be constructed in India.The purpose of ECBC is to provide minimum requirements for energy-efficient design and construction of buildings and their systems. The building sector represents about 33% of electricity consumption in India, with commercial sector and residential sector accounting for 8% and 25% respectively. Estimates based on computer simulation models indicate that ECBC-compliant buildings can use 40 to 60% less energy than conventional buildings. It is estimated that the nationwide mandatory enforcement of the ECBC will yield annual savings of approximately 1.7 billion kWh. The ECBC is expected to overcome market barriers, which otherwise result in under-investment in building energy efficiency. The ECBC was developed as a first step towards promoting energy efficiency in the building sector. The ECBC is the result of extensive work by the Bureau of Energy Efficiency (BEE) and its Committee of Experts. It is written in code-enforceable language and addresses the views of the manufacturing, design, and construction communities as an appropriate set of minimum requirements for energy-efficient building design and construction. For developing the Code, building construction methods across the country were reviewed and various energy-efficient design and construction practices were evaluated that could reduce energy consumption in building. In addition, detailed life-cycle cost analyses were conducted to ensure that the Code requirements reflect cost-effectiveness and practical efficiency measures across five different climate zones in India. While taking into account different climate zones, the Code also addresses site orientation and specifies better design practices and technologies that can reduce energy consumption without sacrificing comfort and productivity of the occupants.

III. APPLICABLE BUILDING SYSTEMS

The provisions of the ECBC apply to:

- Building envelopes, except for unconditioned storage spaces or warehouses
- Mechanical systems and equipment, including heating, ventilating, and air conditioning, (HVAC)
- Service hot water and pumping
- Interior and exterior lighting
- Electrical power and motors

Specific compliance requirement of the above building components and systems are discussed in following part.
Exemptions to above the provisions of this Code do not apply to:

- Buildings that do not use either electricity or fossil fuel
- Equipment and portions of building systems that use energy primarily for manufacturing processes

Whole Building Performance (WBP)

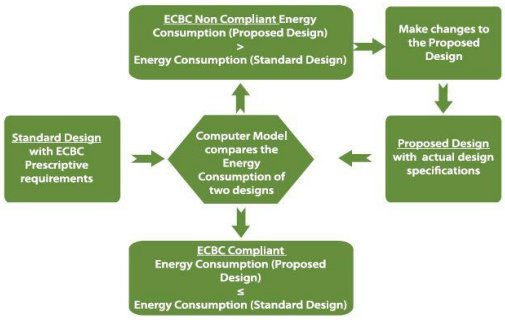

Fig.Whole Building Perfomance

It is an alternative method to comply with the Code. This method is more complex than the Prescriptive Method, but offers considerable design flexibility. It allows for Code compliance to be achieved by optimizing the energy usage in various building components and systems (envelope, HVAC, lighting and other building systems) in order to find the most cost-effective solution. WBP method requires an approved computer software program to model a Proposed Design, determine its annual energy use and compare it with the Standard Design of the building.

General Design Considerations

Using efficient lighting equipment and controls is the best way to ensure lighting energy efficiency while maintaining or even improving lighting conditions. For instance, modern fluorescent lighting, such as electronically ballasted T-8 systems, can provide the same quantity of light as older fluorescent lighting while consuming as little as

two-thirds of the energy. Similarly, compact fluorescent sources are three to four times more efficient than the traditional incandescent lamps they are designed to replace. For a lighting designer an energy-efficient lighting design involves sensitive integration of many requirements and considerations that include building orientation, interior building layout, task illumination, daylight strategies, glazing specification, choice of lighting system and controls etc. The designer is also responsible for making sure that lighting complies with the Code, meeting both mandatory and prescriptive requirements.

The lighting requirements in the Code apply to:

a) Interior spaces of buildings.

b) Exterior building features, including façades, illuminated roofs, architectural features, entrances, exits, loading docks, and illuminated canopies.

Service Exceptions to above:

a) Emergency lighting that is automatically off during normal building operation and is powered by battery, generator, or other alternate power source.

b) Lighting in dwelling units.

DESIGN BUILDER SOFTWARE V 2.3

Introduction-

The design Builder software is an advanced graphical user interface that has been specially developed to run Energy plus Simulations. For UK and Republic of Ireland users Design builder Interface can also be used to produce Energy Performance Certificates (EPCs) and to show compliance with the building regulations. Design Builder is a state-of-the-art software tool for checking building energy, CO2, lighting and comfort performance. Developed to simplify the process of building simulation, Design Builder allows you to rapidly compare the function and performance of building designs and deliver results on time and on budget. Design Builder combines rapid building modelling and ease of use with state of the art dynamic energy simulation. Design Builder is easy to use. Its innovative productivity features allow even complex buildings to be modelled rapidly by non-expert users. Design Builder is the first comprehensive user interface to the Energy Plus dynamic thermal simulation engine.

- To get accurate environmental performance data and stunning rendered images/movies at any stage in the design process.

- Streamline the design and evaluation process by providing performance data when it is most needed... early on while the design is still fluid.

- Design Builder is priced competitively and - more importantly - it is cost-effective to learn and use. And because Design Builder is so quick to use, you will be able to offer advanced simulation on even the smallest project without going over budget.

- When used as a learning tool in universities and colleges, Design Builder s' intuitive user interface and intelligent defaults allow students to concentrate on coursework without getting lost in the detail of using the software.

- Helps you to design environmentally friendly buildings.

1) *4.1.1 Features*

- Design Builder features an easy-to-use Open GL solid modeller, which allows building models to be assembled by positioning, stretching and cutting 'blocks' in 3-D space. Realistic 3-D elements provide visual feedback of actual element thickness and room areas and volumes and there are no limitations on geometric form or surface shape.

- You can import 3-D CAD models from ArchiCAD, Microstation, Revit and any other BIM software supporting the gbXML standard.

- Data templates allow you to load common building constructions, activities, HVAC & lighting systems into your design by selecting from drop-down lists. You can also add your own templates if you often work on similar types of buildings. This, combined with data inheritance, allows global changes to be made at building, block or zone level. You can also control the level of detail in each building model allowing the tool to be used effectively at any stage of the design or evaluation process.

- Switch between Model Edit View and Environmental performance data with a single click - data is displayed without the need to run external modules and import data; and any simulations required to generate the data are started automatically.

IV. ANALYSIS

INTRODUCTION

A sample commercial building (AppendixA) has been considered for carrying out the analysis. The features of the commercial building are as follows:-

- Shopping mall cum office space and restaurant on the 4^{th} floor

- Basement + ground floor + 4 floors-with a basement car parking capacity of 45 cars and 200 bikes.

- Its been provided with a forced ventilation system
- Plinth Area=2255m^2
- Framed structure with a glass façade
- Substructure are cast of concrete and the superstructure is brick masonry
- An estimated external wall-window percentage is 70%
- It has a common atrium which starts from ground floor to 3rd floor and with a skylight above
- It has 2 passenger lift – one service lift - one main stair and 2 fire stairs
- Each floor has one gents toilet, one ladies toilet and toilet for disabled
- An electrical room and a fire room is given in the basement
- All other service equipment s are designed to be on the building terrace
- HVAC system is provided for the whole building

A. *5.2 METHOD OF ANALYSIS*

- The plans are exported in DXF formats from AUTOCAD to Design Builder
- The sketch of the building is made as per the plan
- Site orientation and region is selected
- Material of construction is selected from the material library
- Building parameters are entered in accordance with ECBC standards.
- The building is divided into different zones for simulation purpose with a maximum of 50 zones as per limitations of the trial version software
- Zones which shares common open spaces are fused such as atrium, stairwell etc.
- Building visuals are generated to check with the architectural features
- Heating and cooling design are analysed and studied
- Simulation of the software is done for the specified week and output data are analysed

Table- **Inference Table**

	CASE1	CASE2	CASE3	CASE4	CASE5	CASE6	CASE7
TOTAL ELECTRICAL LOAD(KWH)	86197	84525	85324	81334	86786	82114	79571
CARBON FOOT PRINT(Kg)	59045	57900	58447	55714	59448	56248	58886
TOTAL SOLAR HEAT GAIN(KW)	53786	33536	35110	20548	24627	28386	33536
INTRADAY HIGHEST SOLAR HEAT GAIN(KW)	797	504	545	327	381	418	504

V. CONCLUSION

- From the analysis of this dissertation we have conclude that in building design, by using simulation software(design building software), as per ECBC standards adopting various cases we found out the best orientation of building which gives more energy efficient.
- Simulation software is an effective tool for designing energy efficient buildings. The scope of the software is vast and could generate better results in comparison with other conventional methods employed for designing such buildings.
- The ECBC is expected to overcome market barriers, which otherwise result in under-investment in building energy efficiency. Widespread awareness and support is essential for its effective implementation and eventual enforcement. The compulsory use such standards and software would facilitate generation of energy efficient building designs.
- Design Builder models can be easily configured to represent the full technical specification of the building and provide robust analysis of its environmental performance.

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