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Evaluation of Building Energy Performance

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Abstract — Building sector in India is witnessing huge interest in the field of energy performance of buildings. The building energy simulation programs are increasingly employed in the design process to help Engineers and planners to determine which design alternatives save energy and are cost effective. This paper presents the brief literature about the building energy standards in India, energy performance simulation of buildings and evaluates the energy performance of a single room with the help of ArchiCAD [Graphisoft] software tool.

Keywords --- National rating systems, Energy performance simulation of buildings, energy analysis.

I. INTRODUCTION

In India, building sector accounts for 35 % of total final energy consumption and building energy use is increasing at 8% annually (Rawal et al., 2012). Commercial sector & residential sector accounts for 8% & 25 % respectively. If this trend continues to grow, the final energy demand of the Indian building sector will be over five times by the end of the century (Chaturvedi et al., 2014). The Government of India had issued the energy conservation building code (ECBC) code in 2007, applicable for commercial buildings with a connected load of 100 kw or 120 kVA. Majority of buildings in India, are not ECBC- compliant. As per the studies, it is estimated that the implementation of ECBC code could save 25-40% of energy as compared to conventional buildings (IEEMA, 2007; Tulsyan et al., 2013). The United Nations Development programme reported that, the ECBC code compliance buildings in India would reach to 35 % by 2015 and 64% by 2017 (UNDP, 2012).

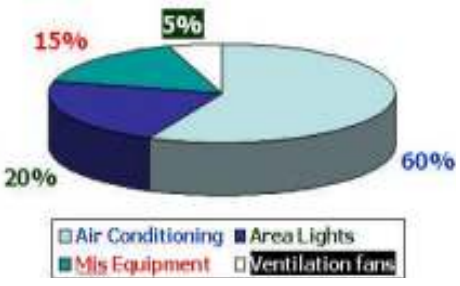

Figure 1. Energy consumption in a building (source: CII)

Figure 2. Heat gain in a building. (Source: CII)

The above diagram (Fig. 1) represents the energy consumption through the electrical equipment and appliances operated in building spaces. Energy consumption is more by air conditioned equipments. Fig. 2 represents the heat gain through building envelope and it is clear from the

above diagram that the heat gain is more through glass panels provided in windows. The glazing should be such that its U (Thermal Transmittance) value and shading coefficient should be low but the VLT (visual light transmittance) to be high.

II. WORKING OF SIMULATION TOOL

Simulation tool/engine is capable to simulate the energy use in a building for every hour of the year i.e 8760 hrs. Tool requires hourly weather data; it handles heating/cooling load calculations on an hourly basis (ECBC code).

2.1 LEED (Leadership in Energy and Environmental Design) India

It is the rating system developed by US Green building Council and recognized as international rating system. This 'LEED' rating system has been indigenized by the (IGBC) Indian Green Building Council to suit the national context. Studies reported that a 'LEED' rated building consumes 30-50% lower energy as compared to a conventional building (CII).

Table 1. Energy savings in LEED rated buildings (Source: CII)

Building	Built up area Sq.ft	Energy consumption of conventional building (kWh)	Energy consumption of LEED designed building (kWh)	% Reduction	Annual energy savings (Rs in Lakhs)
Wipro Technologies, Gurgaon	1,75,000	48,00,000	31,00,000	40 %	102
ITC F Green centre, Gurgaon	1,70,000	35,00,000	20,00,000	45 %	90
CII Godrej GBC, Hyderabad	20,000	3,50,000	1,30,000	63 %	9

Table 1.0 presents the energy performance comparison of three 'LEED Platinum' buildings. The energy consumption is 40 % to 63% less than that of conventional buildings; indirectly cost saving from nine lakh to one crores yearly.

2.2 National Standards

The Energy conservation building code (ECBC), launched by the Government of India, Ministry of Power in May 2007 under the energy conservation Act, 2001 for its adoption on a voluntary basis. It is applicable to buildings or building complexes that have connected load of 500 KW or a contract demand of 600 KVA, whichever is greater. It is recommended for all buildings with conditioned area greater than 1000 sq m. (BEE).

2.2.1 GRIHA (Green Rating for Integrated Habitat Assessment)

It is the national rating system, evaluates the environmental performance of a building. It gives standards for 'green building'. It consists of set of criteria covering various parameters related to design, construction and operation of a green building (MNRE and TERI).

2.2.2 Eco Housing Assessment Criteria

Eco housing criteria evaluates the environmental performance of residential projects in Pune city. It promotes the adoption of environmentally friendly practices, energy efficient products and

techniques by the construction industry. Every stage of building construction incorporates the environmental considerations. Eco housing rating is shown in the following table.

Table 2. Eco housing ratings for residential projects in Pune (http://www.ecohousingindia.org)

Points	Star Rating
500	*
501-600	**
601-700	***
701-800	****
>801	*****

III. CASE STUDIES

3.1 Contrasting the capabilities of building energy performance simulation programs

Drury, et al. (2008): The paper presents an overview, comparison of the features and capabilities of twenty major building energy simulation programs. The important categories of comparison are general modeling features- zone loads, building envelope, daylight, solar- infiltration, ventilation, renewable energy systems, HVAC systems and equipment, environmental emissions, climate data and economic evaluation.

3.1.1 Energy and environmental performance simulation of buildings with corresponding and converged envelope and glazing system

Gyeong, et al. (2012): The work analyses the energy consumption in cooling and heating load in building that is corresponding to converged envelope and glazing ventilation system. The researchers used 'Ecotect V5.5' tool on solar shading effect for setting the shading factor of an exterior blind system on summer, winter and the operation angles in time of transmission. The results state that lower the shading factor of the glass, better the cooling load reduction effect and more effective the whole annual load reduction (45%) compared to the type of glass with the biggest load.

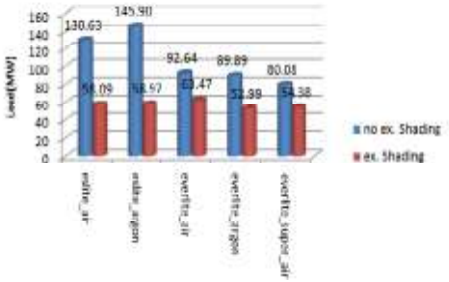

Figure 3. The U value and the SC according to exterior blind (Gyeong, S.C. et al., 2012)

3.1.2 Improving building façade design using integrated simulation of daylighting, thermal performance and natural ventilation.

Wei, et al. (2013): The work is based on computer simulation technique using the tools 'Energy Plus and Fluent'. A graphic user interface has been developed to model the three type of building façade configurations with different areas or position changes. The research states that: the area of opening in building envelope has the most influence on a building's energy consumption. As the opening area increases, the cooling load rises dramatically. Large south window gets more solar energy in the winter, overheating in the summer loses more energy by heat conduction and infiltration. The change of opening positions influences the air conditioning energy consumption.

Figure 4. Major parameters setting of daylights, thermal and natural ventilation simulation modules of Energy Plus (Wei, You. et al. 2013)

3.0 Description of pilot study: The work presents the energy simulation of single Reinforced cement concrete framed structured building based at Pune. Energy performance of the room is evaluated with the help of Graphisoft software tool. Room dimensions are 8300 mm x 4270 mm, Wall thickness is 230 mm, burnt clay brick masonry. The floor finish of the room is provided with tiled flooring. Climate data required for running the simulation engine is obtained from 'Strusoft' server.

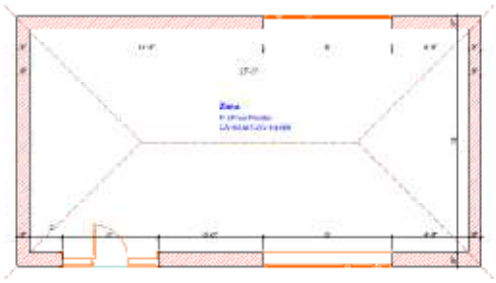

Figure 5. Floor Plan of a room

IV. RESULTS

The energy performance reports generated are shown below. The energy analysis shows that the energy consumed in cooling is 157684 kwh/a and the corresponding primary energy consumed is 292843 kwh/a. Whereas, the energy consumed in lighting and appliances is 1266 kwh/a with corresponding primary energy is 3800 kwh/a. It indicates that, the energy consumption in cooling is far more as compared to the energy consumed in using the other appliances.

Figure 6. a) Energy performance evaluation *Figure 6.b) Energy performance evaluation*

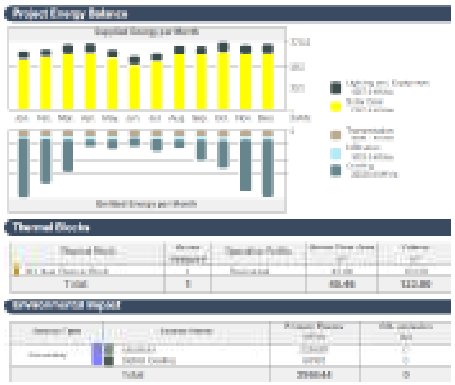

Figure 6. c) Energy performance evaluation

CONCLUSIONS

The total annual energy consumption is 158951 kwh in terms of quantity and the corresponding primary energy consumption is 296644 kwh/a. India being the tropical country, the energy consumption is maximum for cooling it also depends upon the weather at a particular place. The major source of primary energy is coal for electricity generation. The building energy codes are the most effective tools to create energy efficient buildings. The important factor is the implementation of the codes in the building design process and its implementation in the country. The development of energy models allows us to estimate and predict the evolution and behavior of energy consumption in buildings. The data thus obtained are extremely useful for the elaboration of energy-saving measures that can enhance energy efficiency. Energy simulation programmes are excellent tools to design energy efficient buildings.

REFERENCES

[1] Bureau of Energy Efficiency, Ministry of Power, Government of India, "Energy conservation building code (ECBC) – version 3.0, March 2011", New Delhi, India.
[2] Chaturvedi, V., Eom, J., Clarke, L. E., and Shukla, P. R. "Long term building energy demand for India: Disaggregating end use energy services in an integrated assessment modeling framework", Energy Policy, Vol. 64, pp. 226-242, 2014.
[3] Confederation of Indian Industry, "Energy Efficiency in Building Design and Construction", Hyderabad, India, 2012.
[4] Drury, B. Crawley., Jon, W. Hand., Michael, Kummert., Brent, T. Griffith., 2008. "Contrasting the capabilities of building energy performance simulation programs", Building and Environment, Vol. 43, pp.661-673.
[5] Gyeong-Seok Choi., Min-Seon Jang., Jae – Sik Kang., Yong,-Jun Lee., Seung- Eun Lee., Kwang-Seup Chung and Kwan- Seop Yang., 2012. "Energy and environmental performance simulation of buildings with corresponding and converged envelope and glazing system", International Journal of Sustainable Building Technology and Urban Development, Vol. 2, no. 4, pp. 318-322.
[6] Green Rating for Integrated Habitat Assessment, Ministry of New & Renewable Energy, Government of India, version 3.0, May 2013, New Delhi, India, 2010.
[7] Sha, Y., Meredydd, E., and Alison, D. "Building energy efficiency in India; Compliance Evaluation of Energy Conservation Building Code", Pacific Northwest National Laboratory. 23217, 2014.
[8] SP: 41 (S&T) - Handbook on functional requirements of buildings, Bureau of Indian Standards, New Delhi, 1987.

[9] Rawal, R., Vaidya, V., Ghatti, V., Ward, A., Seth, S., Jain, A., and Parthasarathy, T. "Energy Code Enforcement for Beginners: A Tiered Approach to Energy Code in India", Proc. ACEEE Summer Study on energy Efficiency in Buildings, pp 4313-4324; Pacific Grove, CA, 2012.
[10] Sonawane, M. B., and Dr. Mhaske, S.Y. "Use of building energy simulation tools in assessing building performance", Proc. International Conf. on "Contemporary Issues in Engineering & Technology", ISBN 978-81-929261-0-0, Gujrat, India, 2014.
[11] Tulsyan, A., Dhaka, S., Mathur, J., and Yadav, J. V., 2013. "Potential of energy savings through implementation of Energy Conservation Building code in Jaipur city, India, Energy and Buildings, Vol. 58, pp. 123-130.
[12] United Nations Development Programme, "Energy Efficiency Improvements in Commercial Buildings in India", Global Environment Facility Project Document, 2012.
[13] Wei, You., Qin, Menghao., Wowo, Ding.,2013. "Improving building façade design using integrated simulation of daylighting, thermal performance and natural ventilation", Building Simulation, vol.6, pp. 269-282.
[14] http://www.ecohousingindia.org.

