International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

Review of Retrofitting of Academic Building by Energy Efficient Techniques

Brijesh Kumar Shivhare[1], Dr. Mukesh Pandey[2]

[1]*PG scholar's, Civil Engineering Department, ITM University, Gwalior*
[2]*HOD, Civil Engineering Department, ITM University, Gwalior*

---***---

Abstract - *This paper represents the modern techniques which can be implemented for enhancing the efficiency with which building can be designed to meet the needs of occupants for thermal and visual comfort, beautiful and healthy work environment at reduced levels of energy waste and resources consumption. There are various energy efficient techniques like orientation of building, trombe wall construction, solar chimney at roof level, earth air cooling tube at 4m depth below ground level, Photovoltaic cells for electricity generation, double glazed windows with proper sealing to minimize infiltration, sun spaces on south side, earth berming in partly sunken buildings, sun-shading and landscaping by vegetation, adoption of sky garden, providing energy efficient lighting system, use of energy saving electrical equipment's, cavity in the outer walls etc .as well as using low energy materials like insulation products, high performance doors and windows, white glazed tiles for roofing etc. for achieving energy efficiency and to maintain thermal comfort inside the building envelope. Using above techniques and materials, one can effort to save world from severe energy crisis.*

Keywords: Building envelope, cavity walls, Energy Performance Index (EPI), green buildings, solar chimney, urban heat island effect.

1. INTRODUCTION

Energy efficient building require unique construction methods for maximizing the efficiency with which buildings and their sites use resources like energy water and materials while minimizing energy waste, ensuring human health, safety and comfort throughout the building life-cycle without requiring special materials or construction skills.

As the world is facing severe energy crisis, the building sector accounts for more electricity than any other sector, about 42% globally. We spend more than 90% of our time in buildings, consuming major part of electricity which puts a lot of stress in society in terms of electricity shortage and emission of greenhouse gases. With increasing urbanization, higher in developing countries, the number and size of buildings in urban areas will increase, resulting in an increased demand for electricity and other forms of energy commonly used in buildings. In many developing countries including India, there is normally very little margin between existing power supply and electricity demand.

The potential for energy saving is 40% to 50% in buildings. For existing structures, the potential can be as high as 20-25% which can be accomplished by implementing housekeeping and retrofitting measures. The incremental cost acquired for accomplishing energy efficiency is 5-8%. Conventional design cost can have an appealing payback time period of 2-5 years.

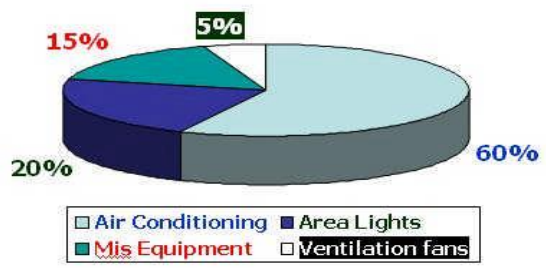

Fig-1: Typical break-up of energy consumption in an academic building

Typical break-up of energy consumption in a building shows that air conditioning is the 60% consumer of energy followed by area lighting 20%, miscellaneous equipment15% and ventilation fans 5%

2. LITERATURE REVIEW

The various literatures are studied to get an overview of the latest techniques and historic examples to adopt an integrated approach in building design.

The Indira Paryavaran Bhavan is India's first net zero energy building that has been constructed with adoption of solar passive design and energy-efficient building materials. In modern India from radiation cooling towers to vertical gardens and geothermal insulation, we review the green buildings and their key features. Most commercial building in India have an Energy Performance Index (EPI) of 200 to 400KWh/m^2/year. In contrast, buildings in Europe and America have an EPI of less than 150Kwh/ m^2/year. For uninterrupted functioning of business and uncompromising energy needs and simultaneously progressing towards sustainable alternatives for energy generation India is developing as a leading I.T. and service power house. Some examples of green buildings in India with key technologies are listed below:

(i) RMZ Millenia Business park, Chennai (Key: Lighting Controls - Daylight sensors, Occulux Sensors)
(ii) ITC Royal Gardenia, Bangalore (Key: High Performance Envelope)
(iii) Turbo energy limited, Chennai (Key: Solar air conditioning
(iv) Hotel Leela Palace, New Delhi (Key: Green and solar reflectance index roof)
(v) Infosys, Pocharam campus (Key: Radiant cooling technology)
(vi) Suzlon One Earth, Pune (Key: Wind hybrid solar charger
(vii) TCS Technopark and Grundfos Pumps, Chennai (Key: Thermal storage)

Major energy saving approaches in buildings are discussed as following:

I. *Orientation of building*:

This is initial step for energy saving. Some tips are given below:

(i) One can minimize exposure on south and west, keeping long façade towards north south direction
(ii) Use of simulation tools and techniques for designing the orientation to slow heat gain and maximize use of natural resources to enhance ventilation, heating and air conditioning system.
(iii) Use of high performance doors, windows and ventilators for energy saving perspective.
(iv) Cavity wall construction in east and west façade sun facing walls.

II. *Earth air heat exchanger*:

It is an underground heat exchanger that is used to capture heat from ground or dissipate heat to the ground. The temperature inside the earth at 4m depth remains nearly constant (about 26°C to 30°C) throughout the year. Earth air heat exchanger acquires the same temperature as the temperature of surrounding earth at its top surface and hence the ambient air ventilated through this system will gives cooling in summer season and heating in winter. This system is cheap alternative to conventional heating or air conditioning system as it not uses compressors, chemicals or burners etc., only blowers are needed for the movement of air.

III. *Solar Chimney*:

An easiest way of improving the natural ventilation of building is using convection of air heated passively by solar chimney. A common form of a solar chimney consists of a vertical shaft for utilizing solar energy to increase natural stack ventilation through a building. The solar energy heats up the chimney during day time so that air within it creates an updraft of hot air inside the chimney. The suction created at the chimney's base can be used to ventilate and cool the building below.

IV. *Trombe wall construction:*

A typical trombe wall comprises 20cm to 40cm thick masonry walls. These walls are painted by a dark black heat absorbing colour and faces of wall having single or double layer of glass. To create a small air space the glass is placed between 2cm-15cm far from the masonry wall. The sun's heat passing through the glass panes is absorbed by the dark painted surface and this heat is stored in the wall and conducted slowly towards inward through the mass of the wall. The glass protects escape of radiant heat from the hot surface of the storage wall. The heat radiated by the wall is trapped within the air gap, again heating the wall surface. It takes at most 10 hours to heat up and to reach the sun rays upto interior of the building so that the room behind remains comfortable through out the whole day and after the sun sets, it receives slow heating evenly for many hours.

V. *Solar water heating system:*

A small drain back reservoir is installed in the collector loop. When this system is filled with water it is only filled to the top of reservoir. Since it is located below the collectors, they remain dry when the pump is not circulating. When the collectors are hotter than the water in storage, the pump circulates the water in the reservoir through the collectors where it is heated. The heat from this water is then transferred to the solar storage tank through a heat exchanger located either in the storage tank or drain back reservoir. When the collectors approach the same temperature as the water in the storage tank or this water has reached a preset temperature, the pump shuts off and all the water drains back the reservoir. The drain back system eliminates all the problems inherent in the other types of systems.

VI. *Sun spaces on south side of building:*

Sun space or solarium is the combination of direct and indirect heat gain systems. It is a system to increase solar gains. The sun spaces directly heats up by the solar radiation and these sun spaces heats up the living spaces by convection and conduction through the masonry walls. The basic requirements of buildings heated by sun spaces include south facing collector space attached yet separated from the building by a thermal storage wall, living space separated from the sun spaces.

VII. *Earth Berming:*

Partly sunken building or earth berming is the technique of reducing heat by sun's radiation. The underground or partially sunken building provides cooling in summer and contrary in winter. In this system, earth over outer walls acts as insulation buffers. It is made in slope around the outer walls of the building to cool the building through cooling effect on south and by insulation of outer walls against sunrays and heat.

VIII. *Evaporative Cooling:*

It is used to lower indoor air temperature by evaporating water. This technique is used in areas of lower atmospheric humidity or hot-dry climatic zone. In this process, the sensible heat of air is utilized to evaporate water so that it cools the air which in turn cools the interior space of the building. The rate of evaporation is increased with increase in contact between water and air. The presence of any water body such as pond, lake, sea etc. near the building or fountain in a courtyard provides cooling effect. The most common application is desert cooler which comprises of water, evaporative pads, a fan and a pump. This technique is being used on a roof top of solar energy center building, gurgaon.

IX. *Photovoltaic cell system*:

Photovoltaic cell capture solar energy and convert it directly to electric current by separating electrons from parent atoms and accelerating them across a one way electrostatic barrier. Efficiency of energy capture of PV cell is increased ten times in past 25 years having vast future scope in generating electric power. These are silicon based punch which receives sun heat and converted into electricity through photoelectric effect which can be directly utilized for lighting and can be stored in invertors.

X. *Cool and Green Roof:*

Techniques to reduce heat gain through roof include green roof, high reflective materials on roof top, thermal insulation and external shading of roof. Green roof is a roof of a building that is partially or completely covered with vegetation and soil that is planted over the water proofing membrane. Green roof moderates the heat flow through roofing system and helps in reducing temperature fluctuations due to the changing outside environment. It reduces the problem of urban heat island, which reduces energy consumption in urban areas. Use of high reflective materials such as broken china mosaic and light coloured tiles at roof finishes reflect heat of the surface because of high solar reflectivity and infrared remittance, which in turn, prevents heat gains and thus help in reducing the cooling load from building envelope. Thermal insulation placed on the external side of the roof reduces heat gain from roof top. Also, shading of roofs through design features like pergola or solar photovoltaic panels helps in reducing incident solar heat on roof top.

XI. Some *miscellaneous techniques* are also reviewed:

· Double glazed window proper sealing to minimize infiltration.
· Sun shading and landscaping by vegetation.
· Fountain court with water columns (to cool the inner atmosphere of the building).
· Air lock lobby at the entrance (to minimize heat loss during entrance and exit)
· Solar heat collector Wall (glazed wall provided in front of the building)
· Use of low VOC (volatile organic compound) and lead free paints on external finish of wall surface.
· White reflecting colour on walls (reflect and reject sun radiation).
· Day light with skylights (roof is provided with glazed panels to allow sunlight in day hours).
· Fenestration and shading (proper design of windows and ventilators in the rooms).
· Energy efficient lighting systems like Light Emitting Diodes (LEDs).
· Reduction of heat gain by air cavity in walls and roofs (hollow air spaces within walls as an attic space, in the roof ceiling).
· Hybrid system with upto 50KW bio mass gasifier (utilizes waste organic materials which are converted into gas for electric power generation).
· Hollow concrete blocks to reduce heat gains (provide thermal insulation against outside sun heat).

3. CONCLUSIONS

The critical review undertaken in this paper covers various energy efficient techniques, materials and examples of energy efficient building in India that can be further adopted by retrofitting in existing structures. Some author emphasize more on low energy consuming materials, related equipments machinery or devices for making buildings energy efficient rather than techniques. This paper is focused on recent trends of energy efficiency in buildings which can be further used for retrofitting and slight modification in an existing or a new structure to boost the use of natural resources and ultimately making it eco-friendly and energy saving throughout the life cycle.

REFERENCES

[1] Energy conservation building code tip sheet for building envelope, March 2011.

[2] Energy efficient buildings in India by TERI and MNRE, New Delhi (2001).

[3] P.S. Jatav, Deepak Rastogi, Dr. M.K. Trivedi, "Energy saving in building by using energy efficient green building materials" IRJMST, Vol. 5 (2014)

[4] Rakesh D Patel, P.V. Ramana "Experimental Analysis of Horizontal and Vertical Buried Tube Heat Exchanger Air Conditioning System" Indian Journal of Science and Technology, Vol. 9(35) September 2016

[5] Ramesh S.P., Emran Khan M, "Energy Efficiency in green buildings- Indian Concept" International Journal of Emerging Technology and Advanced Engineering, Vol.3, Feb.2013, pp.329-336

[6] Sharan Girija, Jadhav Ratan, "Performance of Single Pass Earth-Tube Heat Exchanger: An Experimental Study". Published by Indian Institute of Management, Ahemdabad.(2003)

[7] Sneha Shahare, T. Harinarayana, "Energy Efficient Air Conditioning System Using Geothermal Cooling – Solar Heating in Gujarat, India". Journal of Power and Energy Engineering, Vol. 4,pp.57-71 (2016)

[8] U.S. green building council (USGBC) 2006, UNEP 2007

[9] www.architecturelive.in "energy efficient buildings of India"

[10] www.energystar.gov. "Energy Star Ceiling Fans"

[11] www.isover.com

[12] www.terijn.org "Energy and Resource Institue"

[13] www.trombe-wall.org

[14] en.wikipedia.org/wiki/solar-water-heating

[15] en.wikipedia.org/wiki/ground