Green Building a Step Toward Energy Conservation: An Overview

Manjeet Bansal*
* Department of Civil Engineering, Giani Zail Singh College of Engineering and Technology, Bathinda-151001, Punjab, India, push_kar5@yahoo.com

ABSTRACT

This paper highlights the situations for better understanding of the concept of green building for significant environmental, economic and social benefits regarding energy conservation. Commercial building or non-green building are responsible for usage of considerable number of natural resources, energy and cause several adverse impacts on environment and human health. The green buildings mitigate these effects and improve the building construction and living in process. In this paper energy conservation through natural daylight utilization, natural water heating, insulation and natural ventilation provisions are taken into account as sustainable energy saving building.

Keywords: Green building, Environment, Ventilation, Insulation, Sustainable.

1. INTRODUCTION

The modern comfort living conditions are achieved at the cost of vast energy resources. Global warming and ozone depletion and the escalating costs of fossil fuels over the last few years, have forced governments and engineers to re-examine the whole approach to the design and control of building energy system [1]. Ever since the first oil crisis in 1973, it has been realized that a large percentage of the energy consumed in buildings for their heating, cooling, and lighting is directly related to the way in which the buildings are designed and, particularly, to their architectural features, the properties of the buildings' elements, and the use of space. The theory of the bioclimatic design of buildings, as re-defined by architects in the field of building physics, appears therefore as a logical development and an effective solution to the problem of energy waste in the building sector [2].

One of the sustainable, renewable energy used in building is solar energy and it has important role in the building energy system. It has both beneficiary and non-beneficiary aspect. Beneficiary aspects like use of solar energy for water heating which is utilized in domestic application and natural lightning which reduce the load on artificial lightning. Non-beneficiary aspect of solar energy is that it warms the building during summer so lot of energy is utilized for space cooling and ventilation. These drawback can be reduced by using different technique like building design, green envelop, green material used in building construction, green roof etc. with combination of several solar-related technologies which increase its benefits and reduce cost**.** This paper focus on the energy conservation in a building by different strategies using solar energy.

2. GREEN BUILDING

Green building is also known as green construction or sustainable building or high performance building or sustainable design or green architecture. According to EPA, green building define as the practice of maximizing the efficiency with which buildings and their sites use resources - energy, water, and materials - while minimizing building impacts on human health and the environment, throughout the complete building life cycle-from siting, design, and construction to operation, renovation and reuse [3].

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability and comfort.

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by: Efficiently using energy, water, and other resources; Protecting occupant health and improving employee productivity and Reducing waste, pollution and environment degradation.

By adopting green building strategies, we can maximize both economic and environmental performance. The earlier stage the strategies are integrated in a building project, the more benefits can be obtained. Potential benefits of green building include :

Environmental benefits:

- Enhance and protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste
- Conserve and restore natural resources

Economic benefits:

- Reduce operating costs
- Improve occupant productivity
- Optimize life-cycle economic performance

Social benefits:

- Enhance occupant comfort and health
- Enhance aesthetic qualities
- Improve overall quality of life

3. ENERGY CONSERVATION

Green buildings reduce energy usage by different strategy. To increase the efficiency of the building envelope, (the barrier between conditioned and unconditioned space), they may use high-efficiency windows and insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter [4]. Onsite generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building.

3.1 Energy utilization: Natural Daylight and Water heating

Daylighting provides the opportunity for both energy savings and improved visual comfort. With proper integration of a well-designed artificial lighting system, daylighting can offer significant energy savings by reducing a portion of electric lighting load. An extra benefit is the lowering of cooling load due to the reduction in heat gain from electric lamps. In addition to energy savings, daylighting helps create visually pleasing and productive environment for building occupants. Daylight may be introduced into a building using a variety of design concepts or strategies. Daylight can be used in any building by two ways, sidelighting and toplighting. The key difference of the two is that sidelighting admits light from the perimeter walls of the building while toplighting admit light through the top of the building.

In addition, the design of windows influences the effectiveness of daylight utilization significantly. The daylight design can also be integrated with the artificial lighting system to achieve better energy efficiency. If all these factors are well-coordinated, the benefits of using daylight will be maximized.

Electro-chromic and thermal-chromic windows have been investigated for years [5]. The former become now commercially available and called smart windows can be adjusted by varying the glazing temperature or the electric voltage applied to the glazing. Compared to motorized shades, louvers, or screens, smart windows have the advantages of quiet operation and more compact and aesthetic appearance. When equipped with light or temperature sensors, a smart window can automatically adjust its opacity to allow the right amount of light to go through. Some researchers are now trying to integrate the self-cleaning feature (using special coatings to repel water and ultrasound to shake off dust, for example) with variable opacity to make smart windows maintenance-free. Window coatings and retrofit window films are low-cost alternates of solar-control windows figure 1 [6].

Fig. 1: Sun deflectors and sun lighting system developed for efficient solar utilization in buildings [6]

Solar illumination systems have gained increased popularity in recent years. Indirect and direct, concentrated and non-concentrated solar lights have all been used as a supplementary light source for commercial buildings and residential houses. Figure 2 shows a commercial solar tube that utilizes indirect sunrays.

Fig. 2 Solar tube for indoor illumination [6]

3.2 Space cooling: Insulation and Natural Ventilation

In the present energy and environmental scenario there is no need to justify the need to minimize the energy consumed by building space cooling systems. Energy consumption for space cooling in a building can be reduced

by various methods. Building cooling can be achieved by two methods [7]:

a) ***Reduce the heat entry into the building by envelope designing (Insulation)***

The indoor temperature of a building is dependent on many climatic condition of a place like outdoor temperature, wind velocity, solar radiation etc.; building structure and building thermo physical properties of building materials like wall thickness, area ratio of window to wall, thermal conductivity and specific heat of wall material etc. and indoor heat source and air change rate. Present researches on reflective material for outdoor wall painting have led to the development of suitable materials for solar cooling load reduction.

b) ***Passive and hybrid cooling techniques***

(i) Earth to air heat exchangers (buried pipes)

Air is drawn from the environment us in gan electric fan and cooled by circulating air through the underground duct. The coldness of earth is transferred to air and it is flown into the building. It was verified experimentally that 2–5^{0}C reduction of peak indoor temperature can be obtained as the depth of earth to air heatexchanger ranges between 1.5 and 6.5m, respectively. Many building have been designed and monitored and the performance of this concept is proven [8].

(ii) Evaporative cooling system

Direct evaporating cooling device uses evaporative principle to cool the air entering the building. Droplets of water when evaporated absorb the heat of evaporation from the air and in the process the air gets cooled [7].

(iii) Ventilation techniques

Ventilation is the process of supplying and removing air through an indoor space by natural and artificial means. Natural ventilation (fig. 3) uses outdoor air flow caused by pressure differences between the building and its surrounding to provide ventilation and space cooling. When carefully designed, natural ventilation can reduce building construction costs and operation costs and reduce the energy consumption for air-conditioning and circulating fans. An additional bonus is that no longer will any noisy fan be of your concern.

There are basically two types of natural ventilation that can be employed in a building: wind driven ventilation and stack ventilation. Both of which are caused by naturally occurring pressure differences. However, the pressure differences that cause wind driven ventilation uses the natural forces of the wind where as stack ventilation is caused by pressures generated by buoyancy as a result in the differences in temperature (known as stack ventilation) and humidity (known as cool tower).

Night ventilation is a method by which the structural components is cooled down using cold night air, thus providing reduced temperature of indoor air conditions for the following day. In places where the daily diurnal range of the ambient temperature are high and the low night temperatures are suitable for night cooling, night ventilation can be used. This ventilation system uses a fan to enable accelerated night cooling using ambient air for ensuring sufficient night cooling. However, in the urban location due to increase in air temperature and decrease in wind velocity the efficiency of the night ventilation is decreased [9].

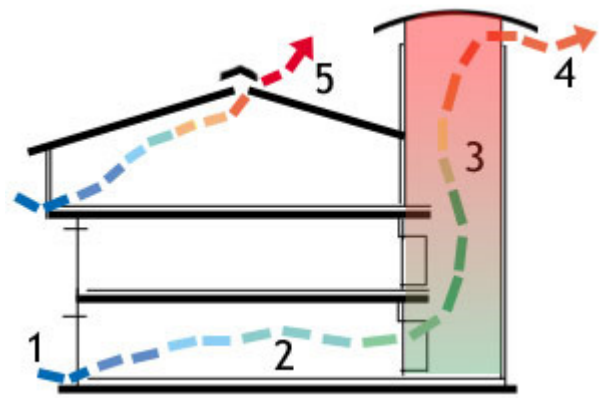

Fig. 3: Cross section through the building showing natural ventilation path

The design for natural ventilation should incorporate following general design considerations:

- Increase air supply intake by ensuring no outside obstruction (such as vegetation or site objects) nor inside obstruction (such as furniture and interior partition) obstruct inlet openings;
- Rooms should have inlet and outlet openings located in opposing pressure zones. This can include openings on the windward and leeward walls or on the windward wall and roof;
- The long facade of the building and the majority of the openings should be should be directed so that the windward wall is perpendicular to the summer wind;
- Use skylights or ridge vents. They are very desirable for night time thermal comfort in houses to vent heated/warm air that rises, and allow heat to be radiated into the cold. It is also can be a good outlet for wind driven ventilation;

- Design for high thermal capacity and exposed ceilings for night cooling.

- Reduce the possibility of wall warming by the sun through use of light-coloured building exteriors, trees/shrubs to provide shading and evaporative cooling, grass and other groundcover to keep ground temperatures low, and ponds and fountains to enhance evaporative cooling.

4. CONCLUSIONS

Solar-powered integrated energy system, involving heating, air-conditioning, natural ventilation and hot water supplying for green building can reduce the load on the energy consumption and increase its self-sustainability which provide environmental, economic and social benefits.

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