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Research Article

A REVIEW OF ENERGY EFFICIENCY IN BUILDING CONSTRUCTION

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ABSTRACT

The construction industry accounts for more electricity use than any other sector. With increasing urbanization, higher in developing countries, the number and size of buildings in urban areas is increasing, which ultimately resulted in an increased demand for electricity and other forms of energy. In most of the developing countries there is not much difference between existing power supply and electricity demand. To meet the increasing electricity demand, new generation needs should be brought in. Researchers are in search and implementation of renewable sources of electricity in the form of hydro, geothermal or wind. Renewable energy sources provide electricity at a much lower cost but their capital investment is huge which is not affordable by common men. Implementation process is also complex and takes much longer time to implement. The close connection between energy use in buildings and environmental damage because the major challenge is to construct a building and meet its demands for heating, lighting, cooling, ventilation, etc. It also causes depletion of invaluable environmental resources. However, buildings can be designed efficiently to meet the occupant's need at reduced levels of energy and consumption of resources. This paper is a detailed review on the energy efficient building along with the possible developments in the future for the benefit of the building designers.

INTRODUCTION

We are in the era of revolution. The industrialized world which is highly dependent on a supply of energy at good prices has reached a breaking point. Depletion of natural resources is exceeding 30% of its natural ability of recovery (WWF 2008). Climate changes, the continuous use of non renewable sources of energy, high energy costs are making our economies vulnerable. These issues call for ways of finding a solution. One way of achieving the solution is to decrease energetic costs and reducing the emission of greenhouse gases. Since buildings contribute about 40% with respect to the emission of greenhouse gases, there is a need to reduce these emissions. Therefore a building with smart design and innovative technology is one way of achieving the goal. The energy efficiency of a building is the extent to which the energy consumption per square metre of floor area of the building measures up to established energy consumption benchmarks for that particular type of building under defined climatic conditions. Hence the use of this technology in building can help in reducing the production of greenhouse gases and at the same time employ renewable sources of energy.

Eco friendly practices in construction industry will help in transition to more sustainable economies, societies related to renewable energy, waste reduction and green building. With the increase in number of green projects, one can see a great future going green (Shristi and Singh, 2014).

Embodied energy databases face wide variety problems due to variation and incomparability. There is no reliable template, standard or protocol for embodied energy computations that could address the problems occurs in embodied energy inventories (Manish, *et al*., 2010).

In order to reach a building that has zero emission

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of greenhouse gases, it is not only crucial that the building operation is comprehensible, and that people get the information they need to operate it, but also that they will want to live and work in zero emission buildings. Therefore, it is essential to take into consideration the use and implementation of low energy buildings (Hinge, 2008).

Today, buildings use approximately 40% of all energy consumed in the world. If we continue on this path of energy use in conjunction with population growth projections, with few new sources of fossil fuels, we could deplete all natural resources within few years. The buildings sector has major opportunity to reduce environmental impact by incorporating energy efficient technologies in design, construction and operation of both new and existing buildings (Jadhav, 2015).

BENEFITS OF ENERGY EFFICIENCY BUILDINGS

The main benefit from measures to improve energy efficiency buildings is lowering the energy costs. Energy efficiency measures are meant to reduce the amount of energy consumed during maintenance or improving the quality of services provided in the building. More than 40% CO_2 emissions in developed countries come from eating, cooling and powering buildings (Ramesh and Emran, 2013; Lee and Yik, 2002; Lee and Yik, 2004; Feijoo, 2002). Energy efficiency investments in buildings will definitely reduce energy use for various activities like heating, cooling and ventilation. It also reduces electricity use for lighting. Such buildings lower maintenance requirements, Improves comfort and enhance property value.

METHODS FOR ENERGY EFFICIENCY IN BUILDINGS

About 40% of the world's energy is consumed by building and 21% of greenhouse gas emission come from building. The building should be maintained very well and then increase energy efficiency like efficient system and appliances, change in user behaviour to create a zero energy building. The basic concept is to use renewable sources of energy like sun, wind, water. When we move internally to the energy efficient building concept, we theoretically analyse the energy concept like net zero site energy, net zero source energy and energy cost, energy emission. Buildings can achieve efficiency in energy level by the methods discussed below (Drury, *et al*., 2008; Marianne and Knut, 2009).

Smart Design

The foremost need to plan for an energy efficient building starts with smart design. The designer and builder should be familiar with the steps involved in building an energy efficient building. Designing concept of such buildings depends upon many factors. The allocations of the rooms in the plan should be done by considering the sun diagram. While designing simpler shapes should be chosen rather than many smaller shapes with lots of architectural complexity. Simpler building structures will be easier and less expensive to build, air seal, and insulate in the field. The thermal boundary on design plans should be clearly mentioned to decide what is inside and what is outside the conditioned space. It would be better if we use only one type of ceiling throughout the house i.e., either flat or cathedral. Orientation of the building plays a vital role for both passive heating and cooling and for maximum solar energy production. Depending on climate, this could involve maximizing passive solar heat gain during cold climates and natural shading in warm climates. If solar panels are used, a direct southern roof orientation is most preferred.

Active Daylighting

The ideal site for an energy efficient building is, it should have unobstructed sun, flat topography, and little exposure to the weather. It should also be located near access to services, shopping, and mass transit. Active day lighting is a system of collecting sunlight using a mechanical device to increase the efficiency of light collection for a given lighting purpose (https://en.wikipedia.org/wiki/Active_daylighting). There are two types of active day lighting control systems such as closed loop solar tracking, and open loop solar tracking systems (https://en.wikipedia.org/wiki/Daylighting). Day lighting is the practice of placing windows or other openings in such a way that during the day, natural light provides effective internal lighting. Particular attention is given to day lighting Energy savings can be achieved from the reduced use of artificial lighting or from passive solar heating. Artificial lighting energy use can be reduced by installing fewer electric lights because or by dimming/switching electric lights automatically in response to the presence of daylight, a process known as daylight harvesting

Barra System

The Barra system (https://en.wikipedia.org/wiki/Barra_system) is a passive solar building technology developed by Horazio Barra in Italy. Barra system uses a collector wall to capture solar radiation in the form of heat. It also uses the thermo siphon effect to distribute the warmed air through channels

incorporated into the reinforced concrete floors and warm the floors. During hot weather, cool night time air should be drawn through the floors similar to air conditioning. To convert the sun's light into heat indirectly, a separate insulated space is constructed on side of the house walls which are under direct sun. Looking at the outside, and moving through a cross section there is an outside clear layer which was traditionally built using glass. The glazing is designed to pass visible light, but it will block Infra Red rays to reduce losses, and block UV to protect building materials from radiations.

Natural Cooling System

Most of our traditional buildings esp. palaces and temples were designed to function on a hot summer without the aid of any modern scientific technology. Movement of air is the most important element of natural cooling system. It cools the internal space by increasing evaporation and carries heat out of the building. Hot air will be replaced with cooler external air. This requires well-designed openings in the form of windows, doors and vents, etc.,as shown in Fig. 1 below.

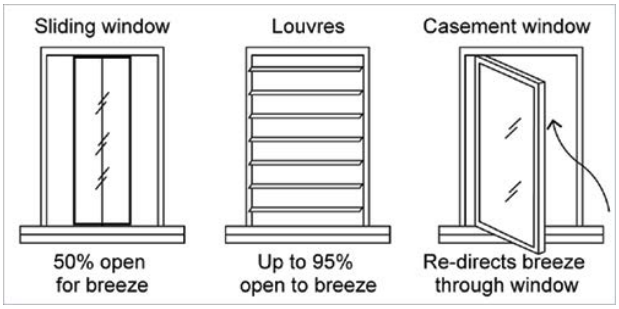

Fig. 1 Windows for efficient cooling.

Source

Department of Environment and Resource Management, Qld

In all climates, movement of air is useful for cooling people, but it will be less effective during periods of high humidity. Depending upon the location, natural sir flow system can be planned. Coastal breezes are usually from an onshore direction. In mountainous or hilly areas, cool breezes often flow down slopes and valleys in late evening and early morning. Thermal currents are common in flatter, inland areas, created by daily heating and cooling (http://www.yourhome.gov.au/passive-design/passive-cooling).

For roofs, which receive the more solar radiation, a proper roof treatment can be made to reduce the transmission of heat waves inside the building. Vegetation in the roof(roof gardens) is also widely adopted to minimise heat transfer inside buildings.

Double Envelope House

A double envelope house is a passive solar house design which collects solar energy and allows the warm air to circulate around the house between two sets of walls called a double building envelope (https://en.wikipedia.org/wiki/Double_envelope_house). The term double envelope house implies a house within a house because of its two walls. Between the outer and inner wall, there will be an air space which is about a foot wide. The temperature difference between the inner wall and air space is quite small.

Earth Sheltering

Earth sheltering is a practice of using earth as a plastering material against the walls to control the external thermal mass. Earth sheltering has been practicing from ancient days when human first started building their own shelter. It is still popular in modern times aimed at sustainable architecture. The benefits are extra protection from natural element, energy saving, efficient use of land in urban areas and low maintenance requirements (https://en.wikipedia.org/wiki/Earth_sheltering).

Fluorescent Lighting and Led Lighting

Fluorescent lighting, compact fluorescent lamp and LED lighting are lighting materials that uses fluorescence to produce visible light. Such type of lights is more efficient than incandescent lights since they convert electrical energy into useful light. Compared to incandescent lamps their initial cost is higher, but they have a long lifespan which in turn will minimises their initial cost.

Super Insulation

Transfer of heat through the walls, roof and ground floor of a house can be reduced by super insulation techniques. The principle of super insulation is developed in timber framed houses to make it more thermally efficient. These houses are traditionally insulated with mineral wool or cellulose insulation. However, the performance of an insulating material depends upon the amount of air trapped within it (https://en.wikipedia.org/wiki/Building-integrated_photovoltaics).

Building Integrated Photovoltaic system is an example of super insulation in which conventional building materials are replaced with photovoltaic materials. The advantage of these materials in construction activities is that the initial cost of construction can be minimised by reducing the amount spent on

building materials. It also reduces the and labour that would normally be used to construct the part of the building. These materials help in converting solar energy into electricalenergy. They also collect the sun's energy during winter months and reject it during summer months.

Sustainable Architecture

Sustainable architecture helps in efficient use of construction materials, energy and utility space. Energy efficiency over the entire life cycle of a building is the most important goal of sustainable architecture. Architects use many different passive and active techniques to reduce the energy needs of buildings. The buildings will be designed in such a way that they generate their own energy. While designing a built environment, sustainable architecture uses a conscious approach to energy and ecological conservation.

Sustainable architecture helps in taking decisions which are being used and will be made useful for the future generation (https://en.wikipedia.org/wiki/Sustainable_architecture).

Solar Energy Collectors

Solar energy collector is a device which absorbs the incoming solar radiation, converts it into heat, and transfers this heat to a fluid flowing through the collector. The solar energy thus collected will be carried from the circulating fluid either directly to the hot water or space conditioning equipment from which it can be drawn for use at night or cloudy days.

CONCLUSION

The above-mentioned technologies are among the common ones that are being used these days to achieve a energy efficient building. The buildings however can use passive ventilation, passive cooling and passive lighting which both take down energy use and help open it upto panoramic view of surround hardwood swamp. The Energy efficient building concept has been a very progressive and trending topic at present. Wide acceptance of such buildings may require a lot of assistance from the government, building code regulations or significant increase in the conventional energy. This paper has clearly reviewed on the process of developing and implementing policy on energy efficiency in buildings. However, with a very skilled and experienced designer, the construction of Energy efficiency buildings can be achieved.

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