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A Review Paper on Sustainable Buildings

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Abstract

Nowadays, the world faces many challenges and problems from climate change and global warming. Many studies reported that different industries have huge roles to play for reducing the effect due to climate change and global warming. Specially, the construction industry has the most responsibility about these challenges on the earth. Doubtlessly, the utilization of inappropriate technologies, appliances, and materials in buildings has threatened the environment and human health today. So, there is a significant question, what is the appropriate way to solve these problems in construction industry? The engineers and technologists have realized the environmental problems are from using some technologies and materials which are energy inefficient in construction industry over the past few decades. Scientists suggested the best way to overcome the aforementioned threats is to consider "sustainable" or "green" design for buildings. So, the main intention of sustainable building is to shift from harm to harmless technologies and materials in buildings. Thus, one of the main purposes of this study is to explore sustainable technologies, standards, and materials, which help the buildings, reduce consuming energy and resources, in order to generate a positive influence on people, nature and society. Accordingly, "sustainable" buildings can be friendlier with environment and human, and use key resources such as energy, water, and materials in a more optimised way when compared to conventional buildings.

Keywords: *Global warming, Sustainable building, Technologies, Materials, Environment*

1. Introduction

1.1 Sustainable Building

Sustainable building refers to a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the contractor, the architects, the engineers, and the client at all project stages. The Green Building 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 of green buildings is 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
- Reducing waste, pollution and environmental degradation

1.2 Top Most Sustainable Buildings in India

1. Suzlon One Earth, Pune

It is an Office building. LEED- Platinum rating with 57 points. GRIHA Five Star rating with 96 points.

2. CII-Sohrabji Godrej Green Business Center, Hyderabad

It is a commercial building.

Area is 20,000 sqft. LEED-Platinum for New Construction in 2003.

3. ITC Grand Chola, Chennai

It is a hotel building. LEED Platinum for New Construction category in 2012.

4. Infosys, Hyderabad

Most eco-friendly campus. 450-acre campus at Pocharam. LEED India Platinum rating.

5. Indira Paryavaran Bhavan, New Delhi

It is an office building for Ministry of Environment and Forest (MoEF). Platinum rating by LEED under New Construction. 5-star rating by The Energy and Research Institute's GRIHA (Green Rating for Integrated Habitat Assessment).

1.3 Green Rating Systems in India

Green rating systems for buildings measure and quantify the environmental performance of a given building. India currently has the below green rating systems for buildings.

- Green Rating for Integrated Habitat Assessment (GRIHA)
- Leadership in Energy and Environment Design (LEED)
- Indian Green Building Council (IGBC)

1.3.1 Green Rating for Integrated Habitat Assessment (GRIHA)

Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system of India for any completed construction, endorsed by the Ministry of New & Renewable Energy (MNRE), Government of India and TERI. It is an assessment tool to measure and rate a building's environmental performance.

Basic features of GRIHA

Pre-construction stage: Intra and inter-site problems such as access to public transport, type of soil, kind of land, location of the property, flora, and wildlife on the ground before construction activity starts, the natural landscape and land features.

Building planning and construction stages: Resource conservation and resource allocation problems, energy effectiveness, energy regeneration, and reuse, and occupant safety and wellness regulations. The prime resources that are considered in this section are land, water, energy, air, and green cover.

Building operation and maintenance stage: Issues relating to the operation and maintenance of building systems and procedures, tracking and recording of energy consumption and occupant safety and well-being, as well as problems affecting the global and local environment

1.3.2 Leadership in Energy and Environmental Design (LEED)

LEED (Leadership in Energy and Environmental Design) is the most widely used green building rating system in the world.

LEED India encompasses rating systems for:

- Existing Buildings (EB)
- New Construction (NC)
- Core and Shell (C&S)
- Green Homes

These represent the measurable indicators for global and local concerns in the Indian scenario. Based on the points achieved, the building may be eligible for LEED-certified, Silver, Gold or Platinum Rating.

1.3.3 Indian Green Building Council (IGBC) Rating System

IGBC Rating System is a voluntary and consensus-based programme. This rating system would facilitate the development of energy-efficient, water-efficient, healthy, more productive, environmentally friendly factories.

2. Literature review

1. Addis & Talbot (2001)explained several benefits of green buildings in the form of energy and water saving, reduced maintenance cost, increased property value, higher occupant satisfaction, improved productivity, health benefits, and reduced carbon dioxide and waste.

2. Ashley, (2003) encourage acceptance of any emerging concept it is important to examine the awareness level of the developers because developers are the ones who have a fundamental influence on the entire lifecycle of a sustainable construction.

3. Du Plessis (2007) argues that behavioral change is impossible without personal commitment. To solicit support of all the associated stakeholders, their personal values must be satisfied.

4. Creech and Hydes, (2000) to encourage acceptance of any emerging concept it is important to examine the awareness level of the developers because developers are the ones who have a fundamental influence on the entire lifecycle of a sustainable construction.

5. Kibert, (2016) each and every step-in life cycle of a green building from planning to its demolition should be governed by the principles of green construction industry. These principles are; reduce, reuse, recycle, protect nature, eliminate toxins, life-cycle costing and quality.

3. Methodology

3.1 Materials

1. Materials used for walls

Wood

It is one of the most used natural building materials in the world. A number of valuable properties such as low heat conductivity, small bulk density, relatively high strength to mechanical working etc.

Bamboo

It has high compressive strength and low weight has been one of the most used building materials as support for concrete, especially in those locations where it is found in abundance.

Cork

It is used for flooring, rigid insulation, exterior finish, floor underlayment, acoustic wall coverings and countertops.

Fiber cement

Fiber cement is a composite material made of cement reinforced with cellouse fibers.

Straw bale

Straw bale construction is a relatively sustainable construction method, with straw being a renewable material that is readily available. After the edible part of grains has been harvested, their stalks are disposed of by farmers and in many areas, they are burned. Transforming them into straw bales gives them a new life and reduces the air pollution which results from burning.

2. Materials used for Flooring

Kota stone

It is a fine-grained variety of limestone, found at Kota. It is a district of Rajasthan. It's hardness, non-porous, shine feature makes it popular to use as flooring.

Shahabad stone

It is very economical. It is hard, durable, tough stone. Easy in construction, repair and maintenance.

3. Materials used for Roofing

Steel

Its strength is of great advantage to buildings. The other important feature of steel framing is its flexibility. It can bend without cracking, which is another great advantage, as a steel building can flex when it is pushed to one side by say, wind, or an earthquake.

Slate

It is a fine-grained, foliated, homogeneous metamorphic rock derived from an original shale-type sedimentary rock composed of clay or volcanic ash through low-grade regional metamorphism. It is the finest grained foliated metamorphic rock.

Thatch

Thatching is the craft of building a roof with dry vegetation such as straw, water, reed, rushes, heather, or palm batches, layering the vegetation so as to shed water away from the inner roof.

4. Materials used for Windows

Triple Glazed Window

These windows, when properly installed, have an extensive array of benefits. More rigid and durable than traditional windows, triple glazed windows have an outstanding insulation performance. Especially in areas with extreme weather. Their three layers of glass also provide increased security, the thicker area is harder for vandals to break. Additionally, they offer great energy savings when compared to regular and double-glazed windows.

5. Paints

Non – VOC paints

It is recommended over VOC containing paints. Presence of Volatile Organic Compounds (VOC) in paint reacts with sunlight and nitrogen oxide resulting in the formation of ozone which can cause severe health problems for the occupants.

3.2 Water Efficiency

1. Grey water reuse

Generally used water from the bathroom sinks, showers, tubs, and washing machines. Removal of unwanted suspended material from the grey water collected and disinfecting the same to make it useful for toilet flushing or irrigation. It can save up to 35-40% of water consumption in a residential building by reusing shower & basin water for the use of toilet flushing, irrigation, car washing, cleaning, etc.

2. Water meter

Water metering is the practice of measuring water use. Displacement water meters measure how much water occupies a given space over a preset time. The water flow displaces the measuring device according to the volume of water in either gallons or cubic feet that passes through the meter.

A velocity-type meter measures the velocity of flow through a meter of known internal capacity. The speed of the flow can then be converted into a volume of flow to determine the usage.

3. Rain Water harvesting

Surface runoff harvesting

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

Roof top rainwater harvesting

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very.

4. Water Efficient Plumbing Fixtures

Large quantities of water are saved by the use of plumbing fixtures that are designed to operate with less water. For instance, toilets were once made to operate using 7 gallons per flush, but are now available using only 1.3 gallons (a savings of over 80%).
Showering is one of the leading ways we use water in the home, accounting for nearly 17 percent of residential indoor water use.
Installing motion sensor faucets can save as much as 30% to 50% on overall water use, a saving that should not be taken likely both on financial and environmental cost.

3.3 Energy efficiency

1. Solar Energy
Solar panels placed on the rooftop absorbing as much of the energy from the sunlight. The energy can be used for cooking, heating, etc. It is a renewable energy source.

2. Wind Energy
Wind energy is the use of wind to provide mechanical power through wind turbines to turn electric generators for electrical power. Windmills can also be used to generate electricity for running small equipment.

3. Thermal Energy
It is clean, renewable and popular because it can be harnessed from almost anywhere in the world to produce heat and electricity. It is used to maintain the ambient temperature of the building. It can also be used for heating, cooling etc.

3.4 Indoor Environmental Quality
One of the primary aims of green buildings is to minimize negative impacts on their occupants by creating a healthy, comfortable and productive indoor environment. The performance of indoor environment is described as indoor environmental quality. The quality indoor environment can result in increased occupant satisfaction, enhanced performance and productivity, reduced liability, marketing advantage and lower operations and maintenance costs.

The quality of an indoor environment is commonly defined through the following main factors

1. Ventilation
In homes, the most effective ventilation is achieved through natural cross ventilation. The ideal layout features open able windows located in opposite walls, which creates a breeze path to let in fresh air and flush out stale air.

2. Thermal comfort
Thermal comfort describes the temperature and humidity range in which humans feel comfortable. This range can fluctuate by many degrees and percentages, depending on activity levels, clothing, annual seasons and personal preferences.

3. Product choice
Many materials used in the fit-out and construction of homes and commercial buildings contain Volatile Organic Compounds which pose serious health risks to building occupants. VOC's are found in many common construction materials however alternative low / no VOC products are available on the market including: paints, coatings, sealants, carpets and press wood products.

4. Internal noise levels
Excessive noise generated by neighbours, traffic and hard surfaces that reflect internal sounds can impact occupant's amenity and employee's productivity. In order to ensure comfortable noise levels, Council recommends considering the inclusion of acoustic insulation to internal and external walls, double-glazing to windows, landscaping that buffers traffic noise and a good balance of internal hard and soft finishes.

5. Daylight
Daylight is vital for body functions, gives us a sense of time and place and connects us to our environment. Therefore, habitable rooms with 'borrowed light' should be avoided. Daylight is the combination of direct and indirect sunlight.

Conclusion

Sustainable building is an economically, healthier option and most importantly environmentally responsible idea that more people need to adopt. Sustainable building construction is the need of an hour in developing countries like India. In India, GRIHA, IGBC and LEED are the primary three energy rating tools available for building sustainability assessment. Energy efficiency helps in reduction of fossil fuels and adopts eco-friendly sustainable practices. It also enhances and protects the biodiversity and the eco-system. Water efficiency measures in residential and commercial buildings can reduce water waste, yielding lower sewage volume and is economically benefit. Making building sustainable not only improves the standard of living of people but also helps the future generation to be healthier.

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