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GREEN BUILDING
AN ENVIRONMENT- FRIENDLY CONCEPT FOR BUILDING SECTOR

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Abstract - *There are many definitions of what a green building is or does. Definitions may range from a building that is "not as bad" as the average building in terms of its impact on the environment or one that is "notably better" than the average building, to one that may even represent a regenerative process where there is actually an improvement and restoration of the site and it's surrounding environment. The ideal "green" project preserve sand restores habitat that is vital for sustaining life and becomes a net producer and exporter of resources ,materials, energy and water rather than being a net consumer. A green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources. The optimum design solution is one that effectively emulates all of the natural systems and conditions of the pre-developed site – after development is complete. The best option to meet the energy demand and supply requirement is to "GO GREEN". Here it's a small concept presented in this paper to save environment and energy conversation.*

Key Words: Green building, Go green, LEED

1. INTRODUCTION

Green" Buildings are high performance structures that also meet certain standards for reducing natural resource consumption and environment friendly. When Bill Clinton was elected president in 1992, the green sustainability communities began to spread the idea of "Greening the White House" in America. Later on Bill Clinton announced a plan to make the White House the " model for efficiency and waste reduction. After great efforts and hard work, the new concept had got a overwhelming success of the "Greening of the White House" , other institutions had started working on "Go Green" concept. The Pentagon, The Presidio and the U.S.Department of energy among others have gone green and they established an organization for official Green Building Concept by 1998-99 called USGBC.

The term "Green" refers environment friendly design of building including optimization of resources, using non-conventional energy, storm water and waste water reuse.

The term "Green building" does not mean that the building is made with the products helpful to environment but it applies to construction strategies, building design, operation and maintenance so that it has less impact on human health.

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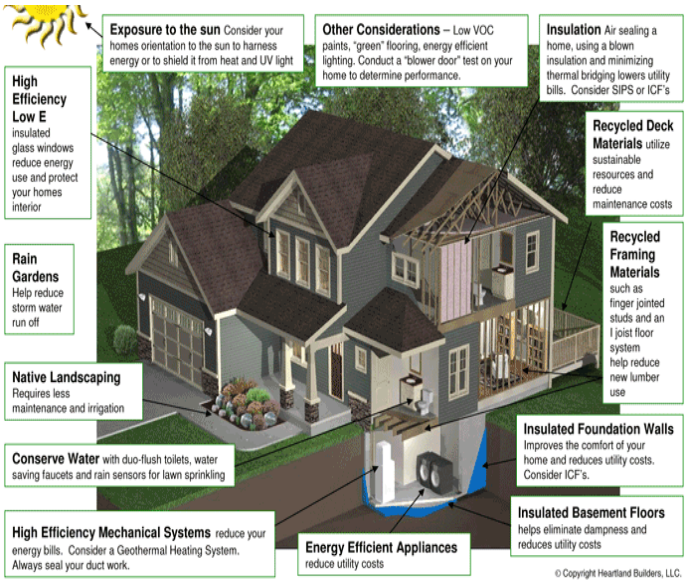


Fig.1 A typical layout of Green building

So in brief, "Green Building" is such a concept that enhance economic health and for betterment of family, community and the environment

2. FEATURES & RATING SYSTEM OF A "GREEN BUILDING"

2.1 Features of a "Green Building"

Till now, we have discussed the history and definition of a "Green Building". But these informations do not clear the idea of "Green Building" or what a "Green Building" actually is. There are some features which should be included to call a building "Green". The features are-

- Energy efficient equipment for air conditioning lighting system & use of onsite renewable energy
- Reduction of building footprint to minimize the impact on environment
- Use of recycled and environmental friendly building material
- Efficient use of water recycling
- Indoor air quality improvement for human safety and comfort
- Installation of high efficiency irrigation methods and selection of vegetation which have low water consumption
- Recycling of construction debris to other sites
- Use of rapidly renewable materials
- Providing daylight and views for the occupied areas

2.2Rating system of Green Building

2.2.1 Type of rating system

A building can have many features mentioned above. To measure the extent of Green features that a building is having , different types of rating system had been adopted like –

A. LEED (US)
B. BREEAM (UK)
C. CASBEE (JAPAN)
D. DGNB (GERMANY)
E. GREEN STAR (AUSTRALIA)
F. IGBC/ LEED (INDIA)

One of the most popular rating system among them is "Leadership in Energy & Environment Design"(LEED) system. This system was first given by USGBC (United State Green Building Council) in 1998. In 2009, Indian Green Building Council (IGBC) had actively promoted Green Building in all over the India.

In addition, LEED- India has developed an idea for setting benchmark on the building performance. The rating levels are "Platinum", "Gold", "Silver", "Certified" indicates the status which meet the requirements of the national codes.

Table-1 LEED Rating System

Particulars	NC		CS		SEZ		HOME		FACTORY	
	M	C	M	C	M	C	M	C	M	C
Sustainable sites	1	13	1	14	3	16	2	9	2	16
Water Efficiency	0	6	0	6	1	25	2	20	2	21
Energy & Atmosphere	3	17	3	14	2	15	2	21	2	23
Materials & Resources	3	17	3	14	2	15	2	21	2	23
Indoor Environment Quality	2	15	2	11	1	10	3	9	3	19
Innovation & Design	0	5	0	5	0	4	0	4	0	5
Project Total										
Silver	26-32		23-27		51-60		30-36		51-60	
Gold	33-38		28-33		61-70		37-44		61-70	
Credit	39-51		34-44		71-80		45-55		71-80	
Platinum	52-69		45-61		81-100		56-75		81-100	

M: Mandatory Requirements/ Prerequisites
C: Maximum Credits
NC: New construction
CS: Core and shell
H: Home

2.2.2 Fundamental principles of Green building

Similar to LEED developed by US Green Building Council (USGBC), LEED – India promotes a whole building approach to sustainability performing in the following five categories -

A. Sustainable sites (P-1)

Minimize urban sprawl and needless destruction of valuable land, habitat and green space, which results from Inefficient low-density development. Encourage higher density urban development, urban re-development and Urban renewal and Brownfield development as a means to preserve valuable green space. Preserve key environmental assets through careful examination of each site. Engage in a design and Construction process that minimizes site disturbance and which values, preserves and actually restores or Regenerates valuable habitat, green space and associated eco-systems that are vital to sustaining life.

B. Water efficiency (P-2)

Preserve the existing natural water cycle and design site and building improvements such that they closely emulate the site's natural "pre-development" hydrological systems. Emphasis should be placed on retention of storm water and on-site infiltration and ground water recharge using methods that closely emulate natural
systems. Minimize the unnecessary and inefficient use of potable water on the site while maximizing the recycling and reuse of water, including harvested rainwater, storm water, and gray water.

C. Energy & Atmosphere (P-3)

Minimize adverse impacts on the environment (air, water, land, natural resources) through optimized building sitting, optimized building design, material selection, and aggressive use of energy conservation measures. Resulting building performance should exceed minimum International Energy Code (IEC) compliance level by 30 to 40% or more. Maximize the use of renewable *energy and other low impact energy sources.*

D. Materials & Resources (P-4)

Minimize the use of non-renewable construction materials and other resources such as energy and water through efficient engineering, design, planning and construction and effective recycling of construction debris. Maximize the use of recycled content materials, modern resource efficient engineered materials, and resource efficient composite type structural systems wherever possible. Maximize the use of re-usable, renewable, sustainably managed, bio-based materials. Remember that human creativity and our abundant labor force is perhaps our most valuable renewable resource. The best solution is not necessarily the one that requires the least amount of physical work.

E. Indoor Environmental quality (P-5)

Provide a healthy, comfortable and productive indoor environment for building occupants and visitors. Provide a building design, which affords the best possible conditions in terms of indoor air quality, ventilation, thermal comfort, access to natural ventilation and daylighting, and effective control of the acoustical environment.

The above mentioned five categories are basic principles of green building and their components are given in tabulated form below-

Table-2

Designation	Principles	Components
P-1	Sustainable sites	1. Site Selection 2. Density and Connectivity 3. Brownfield Redevelopment 4. Alternative Transportation 5. Site Development – Habitat/Open Space 6. Storm water Control 7. Reduction of "Heat Island" Effect 8. Light Pollution Reduction
P-2	Water efficiency	1. Water Use Reduction 2. Water Efficient Landscaping 3. Innovative Wastewater Technology
P-3	Energy & Atmosphere	1. Energy Efficiency 2. Renewable Energy 3. Building Commissioning
P-4	Materials & Resources	1. Building Reuse 2. Construction Waste Management 3. Materials Reuse 4. Recycled Materials 5. Regional Materials 6. Rapidly Renewing Materials

		7Certified Wood
P-5	Indoor Environmental quality	1. Ventilation 2. Low-Emitting Materials 3. Controllable Systems: Lighting - Thermal 4. Thermal Comfort 5. Daylight & Views

2.2.3 LEED certification scorecard breakdown of principles of green building

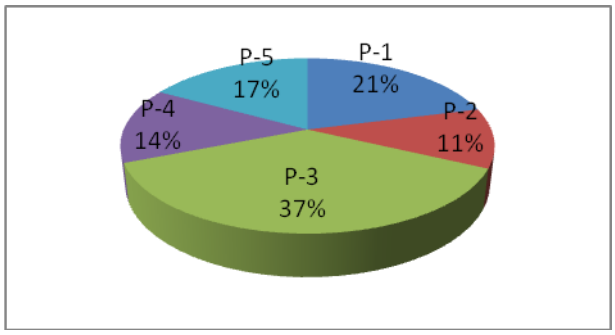


Fig.2 LEED certification scorecard breakdown

3. BENEFITS AND LIMITATIONS OF GREEN BUILDING

3.1 Benefits

- It reduces consumption of energy by 26% as per US General Services Administration Output.
- It reduces consumption of water by 54% as per US General Services Administration Output.
- It reduces the emission of CO_2 gas by 33% as per US General Services Administration Output.
- It reduces wastage of solids by 70%
- It incorporates latest Technologies and Techniques
- It provides health and safety to building occupants
- It improves productivity of occupants

3.2 Limitations

- The cost of materials used as components of green building is very high so that it cannot be afforded by ordinary people
- Some eco-friendly product are not available everywhere
- Lack of expert having the in depth knowledge of Green Building
- It takes more time for construction than a ordinary building

4. MATERIALS/ EQUIPMENTS MEETING THE REQUIREMENTS OF GREEN BUILDING

There are many materials and process by which we can achieve the different requirements of a Green Building. Some of them are listed below

Table-3

SL NO.	MATERIALS/ METHODS	IMPORTANCE
1	Wool brick	Resistant for cold and wet climate
2	Sustainable concrete	Reduce emission of CO_2
3	Solar tiles	Spend large portion of the day absorbing energy from the sun
4	Solar panels	Utilize solar energy for electrification
5	Cavity wall	Protect the house from outside haet
6	Triple Glazed window	Resist the building from direct sunlight and restrict the heat to enter the house
7	Bio-Toilets	In this human waste is digested by anaerobic bacteria in a bio-digester to a completely harmless liquid waste.
8	Roof Garden	They provide good rooftop insulation, protecting

		apartments or offices below from the hot sunlight striking the building from above in summer. In winter they keep warmth from escaping from the building below.

4.1. Explanation of materials/ equipments of table-3

4.1.1 Wool brick

The wool fibers were added to the clay material used in the bricks, using alginate conglomerate, a natural polymer found in the cell walls of seaweed. The mechanical tests carried out showed the compound to be 37% stronger than other bricks made using unfired stabilized earth.

Fig: 3 Wool Brick

4.1.2 Sustainable concrete

Cement and concrete can be produced according to various recipes and with different ingredients. Different production methods lead to different
Qualities and different environmental impacts.
Composing concrete so that it meets the functionalities required and at the same time causes minimum environmental impact is a challenge. Although the production of concrete leads to considerable CO2 emissions, concrete can still be a good choice from an environmental point of view. This is because concrete is strong and has a long service life. These qualities combined contribute to low maintenance costs. Concrete has a higher thermal heat capacity than lighter building materials.
This quality can be used to reduce the amount of energy for heating and cooling during the life time of a building.

Fig: 4 Sustainable Concrete

4.1.3 Solar tiles

In solar tiles most photovoltaic cells are made from silicon, though some thin-film designs use other materials such as cadmium telluride. Traditional solar cells are usually arranged in a flat metal plate interlaced with conductive wires. Thin-film cells are overlaid with a layer of semiconductor material which is only a few microns thick. This makes thin-film cells flexible and adaptable to a variety of shapes. Thus, thin-film solar roof tiles can look and function much like any roof shingle, with the added benefit of solar power generation.

Fig: 5 Solar Tiles

4.1.4 Solar panels

Solar panels are devices that convert light into electricity. They are called "solar" panels because most of the time, the most powerful source of light available is

the Sun, called Sol by astronomers. Some scientists call them *photovoltaics* which means, basically, "light-electricity." A solar panel is a collection of solar *cells*. Lots of small solar cells spread over a large area can work together to provide enough power to be useful. The more light that hits a cell, the more electricity it produces, so spacecraft are usually designed with solar panels that can always be pointed at the Sun even as the rest of the body of the spacecraft moves around, much as a tank turret can be aimed independently of where the tank is going.

Fig: 6 Solar Panel

4.1.5 Cavity wall

It is the external wall of a house is constructed of two masonry (brick or block) walls, with a cavity
(gap) of at least 50mm between. Metal ties join the two walls together.

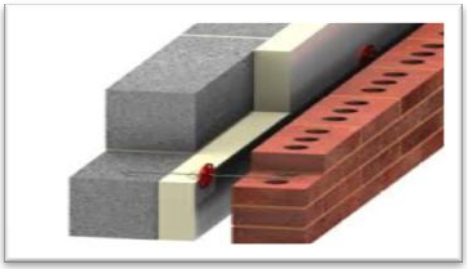


Fig: 7 Cavity Wall

A polyeurathene foam is sandwiched between two walls. The purpose of using this kind of wall is to resist the heat

from outside and keep the house thermally insulated

Fig: 8 Polyurethane Foam

4.1.6 Triple glazed window

Generally Triple Glazed Windows suits houses that have comprehensive insulation throughout to include the walls, roof etc. so that the benefit gained by the triple glazed windows is not lost through other parts of the house. So for your own home it is worth looking at the following:

- The existing insulation in the roof and walls
- The orientation of your house
- Whether noise reduction is important
- Where and how much glazing you are looking to install

The perfect scenario would be to use triple glazing on the North facing aspect of the house to achieve optimum Insulation - with no direct sunlight there is no solar gain. Then on the East, South and West facing aspects use double glazed windows to achieve the balance between Insulation and any solar gain that might be available

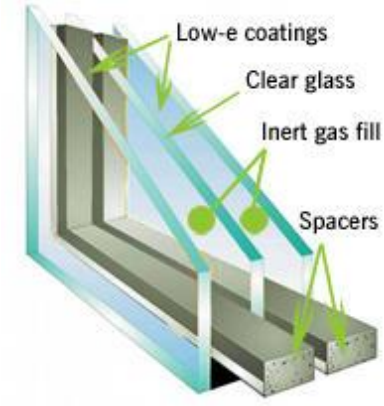


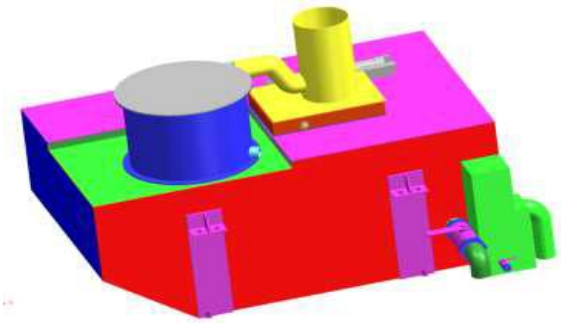
Fig: 9 Triple Glazed Window

4.1.7 Bio-toilet

Bio- Toilets or as called Bio-Vacuum Toilets consume less water and produces no waste.

In these Bio-Vacuum Toilets , the flushed out faecal matter is transferred into a bio-digester , which eliminates the need to create a separate ground handling installation like septic tank.The bio-digester contains anaerobic bacteria that convert human faecal matter into water and small amount of gases like Carbon Dioxide and Methane before discharging.

It has the capability of conserving of conserving water upto 20 times than that required in current toilets. The anaerobic bacteria also inactivates the pathogens responsible for water-borne diseases. This can reduce organic waste upto 85%.



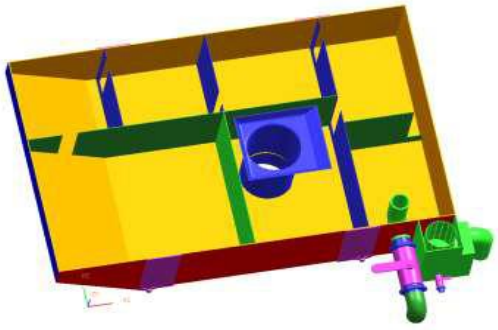


Fig: 10 Bio Toilet

4.1.8 Roof garden

Roof gardens, located on buildings, go some way to restoring to nature an equivalent amount of biodiversity-bearing soil and growing area to the land covered by the building. Like any city garden they can provide much needed green space for people to enjoy.

Additionally, they provide good rooftop insulation, protecting apartments or offices below from the hot sunlight striking the building from above in summer. In winter they keep warmth from escaping from the building below. The layers of moist soil, mulch and plants act to stabilise the building's temperature despite outside variation.

Fig: 11 Roof Garden

4.1.8.1 Construction

- Thick concrete slabs, on load-bearing perimeter walls of 300mm aerated concrete blockwork and two internal columns running from ground to roof.

- Drainage outlets placed at 3 – 4 metre intervals were reduced in number in the final construction.
- Two layers of bituminous, heat-welded waterproof membrane were applied to minimise potential for leaks.
- A layer of sand was spread over the bituminous layer as a bed for butt-jointed concrete pavers providing mechanical protection against garden implements.
- A proprietary polyethylene mesh was laid as a drainage layer.
- Geotextile was laid on the mesh followed by a thin layer of sand.
- A growing medium of 350 mm soil is laid for growing plants.
- Clay pavers have been used to deliniate between pathways and growing spaces. Mulch and gedye bin compost is used to improve the moisture holding capacity of the soil.
- An irrigation system of microsprays keeps it watered with recycled water during summer.

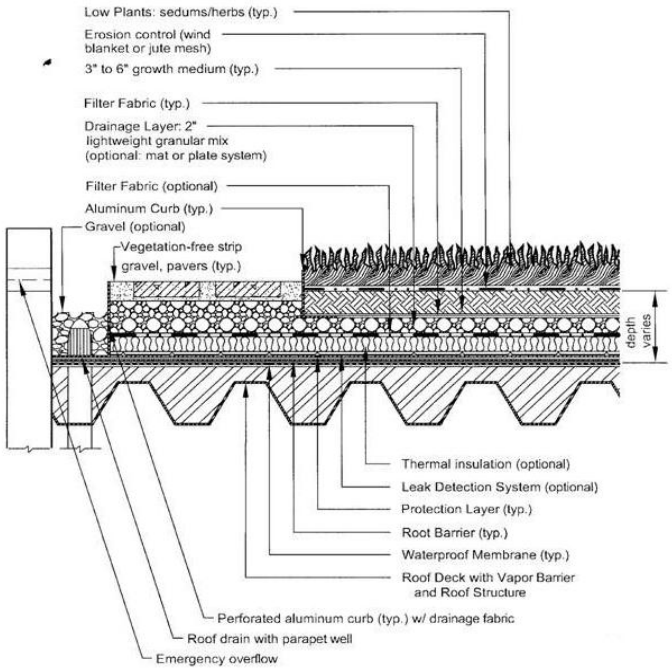


Fig: 12 Typical section through Roof Garden

5. CONCLUSION

After discussing about green building, it may be concluded that the concept behind " Go Green" has many advantages and disadvantages but the weight age of advantages became dominant over disadvantages . It has a great impact on environment and resources such as reduction of consumption of energy, water, reduction of CO_2 emission which benefits not only plants but also human life. This idea has the capacity to meet the modern innovations, technologies etc. In short, the word " Go Green" contributes not only for the betterment of individuals, society, country and global environment but also it takes the modern civilization to an another level of excellence.

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