# A Review on Green Building Movement in India

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**Abstract:** At present, we all are aware of how Green House Effect, resource depletion, environmental degradation is increasing day by day in our planet. Earth is badly in need of sustainable development by reducing pollution, reducing dependence on natural resources, reducing Global Warming etc. Else, after almost 200 years, there will be no life on Earth as predicted by Professor Stephen Hawking. It will be similar like any other planets where it is impossible to live. Even the smallest changes that we can make will help to promote a better Earth as similar to butterfly effect. The developed countries are more advanced in their technologies and rules to have ecofriendly constructions. Whereas the developing countries are not so much aware of this fact. The studies and the research works in these countries are also way far behind as compared to the developed nations in the world. But exceptionally, India being a developing country, it is quite advanced in this aspect and have a good rank when compared to all other countries. Aim of ecofriendly constructions or green building projects is to reduce the significant impact of construction industry on the environment. There are certain criteria on the basis of which a building is rated and certified. It assures that the building would follow those criteria throughout the life of the building. Government of many states in India provides incentives for such kind of constructions. Green buildings not only save nature to a great extent but also save the inhabitants by providing an healthy environment to live in. This paper will make people know about the Green Building Movement in India and how Green Buildings are designed so that they can save the Earth from degradation. The Green Building rating system and their process of certification are mentioned in this paper. One who reads, would also get to know about the barriers faced to have ecofriendly constructions in India and the rank of the country in producing sustainable built environment when compared to all other countries.

**Index Terms**: eco-friendly, efficiency, Green Building, rating, recycle, reuse, resource, sustainable development

## 1 INTRODUCTION

IN India, the Green Building Movement was adopted by the Confederation of Indian Industry (CII) in 2001.They formed the Indian Green Building Council (IGBC) which is actively involved in promoting the Green Building concept in India. Their vision is, "To enable a sustainable built environment for all and facilitate India to be one of the global leaders in the sustainable built environment by 2025". The Green Building movement in India started gaining momentum since 2003,from just about 20,000 sq.ft in 2003 to 450 crores sq.ft green footprint in India today [13]. A green building is one, which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. It is also known as a sustainable or 'high performance' building [22]. There are various systems in the form of design standard or practice code worldwide to enhance the use of green building design. Usually their performance is based on certain sustainability criteria which are combined to assess the design effect [17]. These criteria, in general, focuses on sustainable sites, water efficiency, energy and atmosphere, material and resources, indoor environmental quality.


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## 2 CRITERIA FOR GREEN BUILDING CERTIFICATION

### 2.1 Sustainable sites

Site selection and design play important roles in both reducing greenhouse gas emissions and helping projects adapt to the effects of climatic change. When planning a green building project, design and construction professionals will consider strategies to maintain an environmentally appropriate site. Strategies for sustainable sites include encouraging the development of an environmentally friendly transport plan, protecting and restoring the natural habitat, controlling storm water and reducing heat island effect [9].

**Restore Habitat:** Green building can promote biodiversity by promoting and restoring surrounding habitats or conserve existing natural areas. Areas to avoid include prime farmland, flood plain, critical habitat, public parks etc.

**Storm Water Control:** Stormwater runoff can cause flooding, pollution, and significantly, soil erosion. Thus, storm water management is an important feature of green building construction. It is a process to treat, collect, reduce stormwater runoff using plants, soils, microbes and engineered systems like underground detention tanks.

**Heat Island Effect:** It is the absorption of heat by hardscapes and it is radiated to the surroundings altering microclimate and wildlife habitats. A microclimate is a local atmospheric zone where the climate differs from the surrounding area [18]. These changes can affect native species and biodiversity. To avoid these outcomes, green building construction projects can implement strategies like shading, vegetation and installing surfaces with high solar reflectance indexes etc. Use of high albedo roofing material or heat resistant paint or china mosaic or white cement tiles or any other highly reflective materials over the roof to cover atleast 50% of the exposed roof area is essential. Shade-giving trees are to be planted to cover atleast 75% of the open parking areas [32].

### 2.2 Water Efficiency

We are going to face a Global water crisis in the near future according to U.S. Geological Survey. Urbanization, high population growth rates, climatic changes, lower precipitation amounts, higher temperature are the most important reasons behind ground water depletion. A hydrological study conducted by University of Arizona Cooperative Extension assess that, by harvesting rainwater, we will be able to minimize the devastating effects of droughts, rainfall runoff and non point source pollution. Rainwater collection also allows ground water accretion. Although rain water is non potable, it can be safely used for lawn irrigation, toilet flushing and washing cars [23]. In residential buildings, the majority of water (between 50% and 80%) falls into the grey water category and can be collected for reuse [19]. Grey water system can be introduced to save water. Grey water system is a method of collecting water that has been used for one purpose and then recycle it to use for other purpose. Green constructions ensure that water is harvested, used, purified, reused during entire construction period and also minimise water wastage and increasing recycling methods by installing mechanisms throughout the building life cycle [24]. IGBC Green Buildings rating system encourages use of water in a self-sustainable manner through reduce, recycle and reuse strategies. By adopting this rating programme, green buildings can save potable water to an extent of 30 - 50% [12].

### 2.3 Energy and Atmosphere

Improving energy efficiency is one of the easiest way to save money and improve the sustainability of a building.

**Climate approach passive design:** Passive strategies such as shading, natural ventilation can reduce the demand on active mechanical systems. After observing that which part of the building receives sunrays during afternoon and incorporate shading strategies is an usual practice. Applying window film with an solar heat gain coefficient less than 0.3 helps in blocking the Sun's heat. Selecting light colors for roofing and exterior painting helps to reflect heat from Sun as dark color absorbs heat. Doors and window position and sizes should be designed such that it will allow air flow so that air conditioner is used as less as possible. Effective window placement can provide more natural light and lesser need for electric light during the day [27]. Green building should also incorporate energy efficient lighting (e.g. LED lights), low energy appliances, high efficiency pumps and filters. Properly maintaining building and associated systems will ensure optimal energy efficiency [11].

**Renewable Energy:** Onsite generation of Renewable Energy through Solar power, Wind power, Hydro power can reduce the impact on resources [27]. Substituting renewable energy for conventional energy can substantially reduce emissions of GHGs (Green House Gases) and other pollutants. Obtaining electricity from on-site sources can produce significant cost savings [8]. Through IGBC Green Buildings rating system, buildings can reduce energy consumption through energy efficient - building envelope, lighting, air conditioning systems, etc. The energy savings that can be realised by adopting this rating programme can be to the tune of 20 - 30% [12].

### 2.4 Material and Resources

Though green building materials often called green materials require high initial cost for making a building but leads to low energy consumption expenses and a low maintenance cost which results in decrease in the overall cost of the building [26].

**Reuse and Recycling of materials to reduce waste production:** Green buildings emphasize on the resource usage efficiency and also press upon the three R's - Reduce, Reuse and Recycle [26]. Reusing elements of a previously constructed building can help in sustainable development and in waste management. Vintage brick salvage, wood wastes, materials from abandoned buildings, old docks etc. can be reused in construction of new building. Some building materials include a number of ingredients where certain components may come from recyclables (e.g. of materials with recycled content include cement, rebar, paint etc.) [20]. During the construction phase, one goal should be to reduce the amount of material going to landfills. The waste generated during construction should be segregated based on its utility and should be sent for recycling [32]. Well-designed buildings also help to reduce the amount of waste generated by the occupants as well, by providing onsite solutions such as compost bins to reduce matter going to landfills [27].

**Regional materials:** The goal of using regional materials is to support the use of indigenous resources, help the local economy and reduce the transportation impacts [20].

**Rapidly Renewable Materials:** Extracting certain raw materials can have an impact on biodiversity of the area. The renewable materials have the ability to grow back, but it takes time to re-establish ecosystems. In the meantime it may increase green house emissions and affect the other species. For this reason, it is important to use rapidly renewable materials that mature in 10 years or shorter life cycle such as bamboo, wool, cotton insulation, linoleum, wheat board, straw board, cork etc.[20]

**Durable materials:** Products should stand for a long time and require little maintenance. This will save time, money and energy on repairs at a later date [6].

**Water efficient materials:** Water Conservation can be obtained by utilizing products, materials and systems that help to reduce water consumption in buildings and landscaped areas, and increase water recycling and reuse [6]. Other materials that should be used are high reflective paints, high performance glass, low VOC adhesives, eco-friendly chemicals, solar water heaters, efficient pumps & motors, timer based control on lawn sprinklers, LED lighting fixtures, efficient BEE labelled air conditioners and refrigerators etc. [10] Equipments used in the building are to be free from CFCs, Halons or any other ozone depleting substances [32].

**2.5 Indoor environmental quality (IEQ)**
IEQ is designed to offer comfort, productivity, well being of occupants in buildings. Proper ventilations and air filtrations are included to ensure sufficient flow of fresh and clean air. Exhaust systems in bathrooms and kitchens should be adequately designed to maintain indoor air quality [32]. The materials used in the interior of buildings are also should be eco-friendly with zero VOCs (Volatile Organic Compounds).Other techniques are no smoking, fixing leaks, eliminate aerosols, pet cleaning, planting, car exhaust control etc. [7]. In the book 'Natural Capitalism' it is written that, 'Green buildings create delight when entered, serenity and health when occupied, and regret when departed.'

## 3 FEATURES OF SOME GREEN BUILDINGS IN INDIA [34]

**Suzlon One Earth,Pune:** Suzlon one earth is 100% powered by onsite and offsite renewable sources. The campus has 18 hybrid wind turbines that fulfil 7% of the total energy consumption, the rest of energy demand is met from offsite wind turbines. The structure is designed in such a way that it can get a maximum daylight exposure which helps in reducing artificial lighting consumption. The infrastructure within the campus is designed to enable water percolation and thereby control storm water runoff thus, contributing towards an increased water table level.

**Rajiv Gandhi International Airport (RGIA), Hyderabad:** The structure of the airport is planned in a way so as to consume less water, electricity and conserves natural resources. Within the campus of the airport, there is a green belt of about 273 hectares having numerous plants. RGIA has been successful in saving energy for nearly 3.97 million kWh and have reduced the carbon footprint by 3331 tons.

**CII- Sohrabji Godrej Green Business Centre, Hyderabad:** The building doesn't let out any waste and recycles it all within. It can be said that building is literally made up of only recycled materials.

**Infosys Limited, Mysore:** The 5 storey structure has been built keeping in mind a holistic approach to sustainability in five key areas, including – Sustainable site development, Water savings, Energy efficiency, Materials selection and Indoor environmental quality. The smart mechanism and efficient equipments lead to 40% of less energy consumption.

**Infinity Benchmark, Kolkata:** The building is furnished with $CO_2$ monitor sensors, rainwater harvesting, waste water recycling system and humidification controls. The exterior of the building is made of brick wall block while the roof comprises of deck thick polyurethane foam for better insulation.

**I-Gate Knowledge Centre, Noida:** The building is built over 4,60,000 sq.ft. in Suburban Noida and is designed in a way that it captures 73% of daylight within the office. Nearly 50% of land is covered with grass which doesn't let wastes and sewage water go out.

**Bank Of India, Goa:** A world of eco-friendly lights and air-conditioning, intelligent glazing, modern capsule lifts, and indoor fountains – this is what sums of this popular bank in Goa. The building uses Nano Misty Blue, softening colour glass manufactured by Saint Gobin Glass, India for producing the cool effect and saving energy. The glass has solar control and thermal insulation properties. The building is a complete package of modern look of today's bank.

**Biodiversity Conservation India Ltd. (BCIL), Bangalore:** The building was established with an aim of creating eco-friendly living habitats, especially in the urban space. It is a wonderful example of smart homes where one can turn lights off using mobile phones. The building has 44 interconnected rainwater percolation wells that lead to a 400,000 litre water tank. The building makes use of central reverse osmosis system to purify water without the use of chemicals. Grey water is directed to the gardens, toilets and for washing cars.

**Olympia Tech Park, Chennai:** This tech park has the lowest energy consumption, high natural lighting systems, 100 per cent water recycling and other environment-friendly practices.

## 4 MOST POPULAR RATING SYSTEMS IN INDIA

**(A) GRIHA**: GRIHA or Green Rating for Integrated Habitat Assessment, is the national rating system of India for any completed construction. It has been developed by TERI (The Energy and Resources Institute) and is endorsed by the MNRE (Ministry of New and Renewable Energy).It is an assessment tool to measure and rate a building's environmental performance. Griha is a point based rating system that consists of 34 criteria categorized under various sections such as site selection and site planning, conservation and efficient utilization of resources, building operation and maintenance, innovation etc. It helps with the improvement in the environment by reducing GHG (greenhouse gas) emissions, reducing energy consumption and the stress on natural resources, reducing pollution loads and waste generation [33]. Some GRIHA rated buildings are CESE (Centre of Environmental Sciences and Engineering) building of IIT Kanpur, Suzlon One Earth in Pune, Fortis Hospital in New Delhi, Common Wealth Games Village in New Delhi [16].

**(B) IGBC:** Following the formation of the Indian Green Building Council (IGBC) in 2001, the membership quickly realised the need for measuring "green buildings". IGBC is the non profit research institute having its offices in CII-Sohrabji Godrej Green Business Centre, which is itself a LEED certified building [16]. Since it achieved the prestigious LEED rating for its own centre at Hyderabad in 2003, the Green building movement has gained tremendous momentum in India. Thus, IGBC adopted the LEED for India as an Indian partner of USGBC. It acts as a channel for registration of Indian projects under LEED programme. IGBC building rating system is quite similar to that of USGBC, but slightly modified to suit Indian conditions [21]. The committee included architects, engineers, building owners, developers, manufacturers and industry representatives. This people and professions

added a richness to the process and to the ultimate output. The green design field is growing and changing day by day. New technologies and products are coming into the market and innovative designs are showing their effectiveness. Therefore, the Rating System and the Reference Guide will evolve as well. Construction teams wishing to certify with LEED should note that they will need to comply with the version of the rating system that is mentioned at the time of their registration [2]. LEED-certified buildings have 34 percent lower $CO_2$ emissions and consume 25 percent less energy. Water-efficiency efforts in green buildings are expected to lower the water use by 15 percent and save more than 10 percent in operating costs [29]. Indian Green Building Council (IGBC) has launched several other products for rating of different typologies of buildings including homes, factories, schools, hotels, townships etc. [10]. IGBC started its own exam (known as IGBC AP exam) to identify Green Building professional and award them with IGBC-AP credential. Qualified individuals can be involved in projects registered under the 'IGBC rating programmes' like IGBC Green Homes, IGBC Factory buildings, IGBC Existing Buildings etc [21].

**Some e.g. of LEED rated buildings in India are:**
CII-Sohrabji Godrej Green Business Centre (Platinum), ABN Amro Bank in Ahmedabad (Platinum), Anna Centenary Library Building in Chennai (Gold), American Embassy School **in** Delhi (Gold), Birla International School in Jaipur (Gold), ITC Green Centre-Gurgaon (Platinum), Biodiversity Conservation India Limited(BCIL)-Bangalore (Platinum), Rajiv Gandhi International Airport–Hyderabad (Silver), Suzlon Energy Limited-Global headquarter in Pune (Platinum), Olympia Technology park-Chennai (Gold) [16]. As of September 2017, more than 4,300 projects utilizing green technology, accounting for approximately 4.7 billion sq.ft. of built-up area, are registered in India as per data shared by IGBC. Truely, this is only 5% of the total buildings in India [30]. IGBC is actively involved in promoting green building movement in the country and hopes to rope in 10 billion sq.feet by 2022 [13].

**(C) BEE:** Bureau of Energy Efficiency (BEE) developed its own rating scale based on 1 to 5 star scale. More stars mean more energy efficiency. BEE has developed the Energy Performance Index (EPI). The unit of Kilo watt hours per square meter per year is considered for rating the building. The Government of India set up BEE on March,2002 under the provisions of Energy Conservation Act,2001 [15]. To coordinate energy efficiency, they establish systems and procedures to measure, monitor and verify energy efficiency results in individual sectors as well as at macro level. The Indian Bureau of Energy Efficiency (BEE) had launched the Energy Conservation Building Code (ECBC) on February 2007. The code is set for energy efficiency standards for design and construction with any building of minimum conditioned area of 1000 Sq. mts and a connected demand of power of 500 KW or 600 KVA. The energy performance index of the code is set from 90 kW·h/sqm/year to 200 kW·h/sqm/year. Any buildings that fall under the index can be termed as "ECBC Compliant Building" [28]. Reserve Bank of India's buildings in Delhi and Bhubaneswar, CII Sohrabji Godrej Green Business Centre and many other have received BEE 5 star rating [16]. Among all the buildings, Suzlon One Earth is the only building in India with the highest ratings from LEED (Platinum rating with 57 points which it obtained in 2010) and GRIHA (Five Star rating with 96 points) [14].

## 5 IGBC CERTIFICATION PROCESS

The process includes the following steps [13]:

- Online Registration
- Feasibility Study
- Documentation
- Physical Audit
- Award of Rating

**(A) Online Project Registration**: Project teams who are interested in IGBC certifications for their project are required to first register with IGBC.

**(B) Feasibility Study:** Conducting a project feasibility study is one of the major steps in the process of getting an IGBC Green Certification. This empowers the project team to attain the goal of making building green. The broad areas evaluated during this study are sustainable site selection and planning, sustainable architecture and design, water efficiency, energy and atmosphere, material and resources, indoor environmental quality, innovation and development. Once it is decided to make the project green, the contractors then either have to hire a green building consultant or it is to be done alone.

**(C) Documentation:** It is the most critical step in achieving the desired green building rating. IGBC allows project documents to be submitted in 2 stages:

Preliminary Submission: This phase includes the mandatory requirements and the number of credits a project team aims for. The documents are received by a third party assessor appointed by IGBC. Further, IGBC provides review comments to the project team within 30 days.

Final Submission: This phase includes explanations for the preliminary review queries. The final submission review comments are also given within 30 days by IGBC.

A project team is required to satisfy all the mandatory requirements and minimum number of credit points in each section to achieve an IGBC Green Building Rating. IGBC offers developer-based projects to opt for precertification at the design stage, so that optimization of cost and resources can take place from initial stage. Moreover the developer can exhibit the proposed green features to the buyers. The documents needed for precertification are a brief narrative on project stating project type, number of floors, area etc. Drawings of section, plan, elevation in pdf format is needed. Other documents that are required includes parking plans, contract documents, detail of project design features which will be implemented, material test reports etc. This precertification rating has no relation with final IGBC rating. The final rating will depend upon the implementation of all design parameters detailed in preliminary document [12].

**(D) Physical Audit:** IGBC carries out an exhaustive physical audit of project through a third party assessor team. This audit ensures that project meets all the demands

for rating. In addition, IGBC gathers energy and water performance data annually from all the certified projects to confirm that they are able to achieve sustained performance as envisioned at the design stage.

**(E) Award of Rating:** After validating all the documents and submissions of the project team IGBC rewards a final rating to project. The different levels of ratings are:

| Certified Level | Recognition |
|---|---|
| Certified | Good Practices |
| Silver | Best Practices |
| Gold | Outstanding Performance |
| Platinum | National Excellence |
| Super Platinum | Global Leadership |

The IGBC commemoration and certificate are normally provided to the project at the "Annual Green Building Congress".

## 6 GOVERNMENT INCENTIVES TO IGBC RATED GREEN BUILDING PROJECTS

IGBC is very closely working with several Central and State Government agencies to promote the green building movement in the country. Some of the Central and State Government agencies have given recognition to IGBCs' Green Rating Systems. The list of incentives provided are appended below [31]:

**The Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India,** offers fast track environmental clearance for green building projects which are precertified/provisionally certified by IGBC.

**Government of Punjab**

A. Department of Local Government (Town Planning Wing) offers an additional 5% Floor Area Ratio (FAR) free of charge for projects which are rated Gold or above by IGBC.
B. Department of Housing and Urban Development, Government of Punjab offers an incentive of additional 5% Floor Area Ratio (FAR) free of charge and 100 % exemption of building scrutiny fee for projects which are rated Gold or above by IGBC.

**Urban Development Department, Government of Rajasthan** offers additional 7.5%, 10% and 15% FAR free of charge for projects which are rated Silver, Gold and Platinum respectively by IGBC.

**Government of West Bengal**

A. Government of West Bengal (Department of Municipal Affairs - Kolkata Municipal Corporation) additional 10% FAR for projects which are Precertified / Provisionally Certified as Gold or above by IGBC.
B. Government of West Bengal (New Kolkata Development Authority) additional 10% FAR for projects Precertified / Provisionally Certified as Gold or above by IGBC.

All IGBC rated green building projects in the MSME sector shall be eligible for financial assistance at concessional rates from **Small Industries Development Bank of India (SIDBI).**

**Government of Uttar Pradesh**

A. Government of Uttar Pradesh (Housing and Urban Planning Department): Additional 5% FAR free of charge for projects which are rated as Gold or above by IGBC.
B. Additional 5% FAR free of charge is offered by the Greater Noida Industrial Development Authority (GNIDA) in Uttar Pradesh for projects which are rated as Gold or above by IGBC.

**Pune Municipal Corporation (PMC) and Pune Metropolitan Region Development Authority (PMRDA), Government of Maharashtra** offers an additional FAR of 3%, 5% and 7% for Green Buildings rated as Silver, Gold and Platinum respectively by IGBC.

**Public Works Department (PWD), Government of Maharashtra** has mandated that the renovation of existing buildings and the development of all new government buildings in Maharashtra shall be carried out as per the suitable IGBC Green Building Rating system.

**Government of Andhra Pradesh**

A. Industries & Commerce Department offers 25% subsidy on total fixed capital investment of the project (excluding cost of land, land development, preliminary and preoperative expenses and consultancy fees) for buildings which obtain green rating from IGBC. This incentive is applicable for MSME and large industries.
B. Municipal Administration and Urban Development Department offers the following incentives to projects obtaining the rating from IGBC:

i. 20% Reduction on Permit Fees.
ii. If the property is sold within three years, one-time reduction of 20% on Duty on Transfer of Property (Surcharge on Stamp Duty) on the submission of Occupancy Certificate issued by the Local Authority.

**Government of Himachal Pradesh (Town & Country Planning Dept)** offers an additional 10% FAR for projects which are granted Gold / Platinum rating by IGBC.

**Urban Development and Housing Department, Government of Jharkhand** offers an additional FAR of 3%, 5% and 7% for Green Buildings rated by IGBC as Silver, Gold and Platinum respectively.

**Government of Haryana (Town & Country Planning Department)** ,as per amendment in chapter 6 of the Haryana Building Code 2017 on 8 May 2018, offers an additional FAR (Floor Area Ratio) of 9%, 12% and 15% for Green Buildings rated as Silver, Gold and Platinum respectively by IGBC.

## 7 BENEFITS OF GREEN BUILDINGS

The green buildings reduce certain negative impacts through more effective planning, design, construction, and operation based on the guidelines of green standards. Savings on energy costs and maintenance costs make green building especially attractive to owners [3]. Moreover it provides the users to have good health condition, comfort and an improved overall quality of life. Thus, Green building construction is advantageous in social, economical and environmental aspects. These advantages are mentioned in the following [4],[28],[1]:

- Conservation of scarce national resources.
- Reduction in energy consumption without sacrificing the comfort levels. Energy savings could range from 30 - 40 % (as mentioned in National Building Code), which directly reduce energy bills.
- According to National Building Code (NBC),green buildings save material to about 25- 40% compared to conventional buildings.
- Reduction in destruction of natural areas, habitats, biodiversity etc. and prevent soil loss from erosion.
- Reduction in air and water pollution (with direct health benefits).
- Reduction in water consumption. Water is saved around 36 - 40% as mentioned in NBC.
- Limited waste generation due to recycling and reuse.
- Increase in user productivity.
- Enhanced image and marketability.
- Enhancing and protecting the health and well-being of the occupants.
- Heighten aesthetic qualities.
- Optimize life-cycle economic performance.

## 8 BARRIERS FOR GREEN BUILDING CONSTRUCTION IN INDIA [30],[1]

While green building practices are increasingly being adopted in India, there are few challenges and barriers too. They are as follows:

- Even today, a large section of Indian users is unaware of green buildings.
- Developers already go through a tedious process of multiple approvals and are apprehensive of the additional burden of green compliances in the list of approvals, which can potentially cause more delays.
- The lack or inadequacy of mandatory laws to enforce large-scale implementation of green buildings norms is not helpful.
- There are very few incentive plans, and those that exist vary across states and even cities, depending on different governing bodies.
- In India, architects, engineers, contractors and workers possess less skills and the knowledge required for green buildings construction.
- The initial cost for green building construction definitely involve a higher cost than the conventional ones.

## 9 THE POSITION OF INDIA IN THE WORLD IN GREEN BUILDING CONSTRUCTION

According to the US Green Building Council (USGBC) data, outside United States, India stands in third position (after Canada and China),in annual ranking of the top 10 countries for LEED.

## 10 CONCLUSION

If trees are cut off to clear up the plot for building construction, the same number of trees are to be planted elsewhere. Only this mentality of mankind can save the Earth from destruction. The condition of our planet at present is alarming. The anthropogenic activities mainly lead to such a condition. Scientists are keep on working for invention of technologies which have less or no negative impact on Earth. The researchers state that building construction is one of the main causes of environmental degradation. They are responsible for a huge amount of harmful emissions, accounting for about 30 percent of greenhouse gases, due to their operation, and an additional 18 percent induced indirectly by material, exploitation and transportation [5]. Globally, buildings are responsible for nearly 40 percent of energy use (including 60 percent of electricity use), 40 percent of waste generated (by volume), and 40 percent of material resource use. In cities, buildings occupy 50 percent or more of land area [25].Buildings are responsible for not just a large percentage of the world's water use, but a large percentage of wasted water as well. In order to mitigate the effect of buildings along their life cycle, Green Building (GB) has become a new building philosophy, which uses more environmentally friendly materials, implements strategies to save resources and energy, lowers waste generation, improves indoor environmental quality, reduces harmful gas emissions etc. This might lead to environmental, financial, economic, and social benefits [5]. For instance, savings in operation and maintenance costs in GBs can be realized through the installation of high-efficiency illumination and insulation systems or through a suitable material.

## REFERENCES

[1] A Review paper on Green Building Research by Mr.Apoorva V.Kotkar,prof. Hemant Salunkhe
[2] http://www.indiaenvironmentportal.org.in/files/LEED2011forIndia-NC.pdf
[3] A Review on Sustainable Building (Green Building) by Behnam Neyestani Department of Civil Engineering, De La Salle University, Manila, Philippines
[4] A Conceptual Review of Green Buildings in Energy Saving by Kambam Gireeshma , K.Leleedhar Rao
[5] Sustainable Building Material for Green Building Construction, Conservation and Refurbishing by Usman Aminu Umar, M. F. Khamidi and Hassan Tukur
[6] Selection of Materials for Green Construction: A Review by Geeta Mehta, Amit Mehta,Bidhan Sharma
[7] https://www.conserve-energy-future.com/importance-technologies-design-approache-used-green-building.php
[8] https://www.energy.gov/sites/prod/files/2018/11/f57/onsiterenewables508.pdf

[9] https://www.poplarnetwork.com/topics/sustainable-sites
[10] http://www.epco.in/pdfs/EPCO-Instt/IInd_session/Green_Building_by_Dr_Rama_Pandeya.pdf
[11] https://www.codegreenhouston.org/energy-atmosphere-home
[12] https://igbc.in/igbc/html_pdfs/abridged/IGBC%20Green%20New%20Buildings%20Rating%20System%20(Version%203.0).pdf
[13] http://gosmartbricks.com/indian-green-building-council-igbc/
[14] greenbuildingsindia.wordpress.com
[15] www.beeindia.gov.in
[16] http://greencleanguide.com/three-primary-rating-systems-for-green-buildings-in-india/
[17] Sustainable Green Buildings: A Perspective Review Part – I,by Dr. A.N. Sarkar
[18] http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Microclimate.html
[19] https://www.go-gba.org/resources/green-building-methods/greywater-system/
[20] https://www.poplarnetwork.com/topics/materials-resources
[21] https://rohietgupta.wordpress.com/tag/green-building-codes/
[22] Cost Optimization Using Green Building Concept by Prasang Yadav, Shubhangi Kirnapure, Akshay Gulghane
[23] https://sustainability-certification.com/green-building-rainwater/
[24] www.greeneducationfoundation.org
[25] https://medium.com/when-the-bao-breaks/the-2-other-ways-buildings-affect-the-environment-9504c555aec3
[26] Comparison analysis of Green building materials and conventional materials in energy efficiency performance by Srikant Misra, G.R.K.D. Satya Prasad, Navnit Kumar, Satish Kumar Sah, Sanjeet Kumar, Radheshyam Maurya
[27] Journal of Engineering Research and Studies on GREEN BUILDINGS by Avinash Shivajirao Pawar
[28] IOSR Journal on Role of Green Buildings in Sustainable Construction- Need, Challenges and Scope in the Indian Scenario by Devarshi Tathagat, Dr.Ramesh D. Dod
[29] https://housing.com/news/green-buildings-india-market-headed/
[30] http://sustainabilityzero.com/green-buildings-growth-in-india/ (Article on by Anuj Puri)
[31] https://igbc.in/igbc/redirectHtml.htm?redVal=showGovtIncentivesnosign
[32] International Journal of Modern Engineering Research (IJMER) on GREEN BUILDINGS – ON THE MOVE by B. Sai Doondi,Dr. P Saha
[33] International Journal of Technical Research and Applications on DEVELOPING GREEN BUILDING CONCEPT IN INDIA by Priyanka Rajiv Parikh
[34] https://www.lokaa.in/blog/top-10-green-buildings-india/