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Green Building Design Concept: A Sustainable Approach

Shiv Lal

Department of Mechanical Engineering, Rajasthan Technical University, Kota, India
shivlal1@gmail.com

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Abstract

In this communication, Author has deliberately presented the Green building concept. Green Building is the building which does not required any commercial electricity for the building conditioning. The conditioning means it has sufficient mass flow rate of air, no pollution accumulated inside the building, no extra heat is absorbed by the building and no extra cooling is available inside the building. The building is working in the comfort conditioning zone such as the temperature inside the building lies from 16 to 25 degree Celsius. The Aura of building, LEED Rating of building and comfort conditioning through solar chimney, EATHE, BHE and their integrated approaches has been presented. The ACH for normal and Covid-2 type situation being also discussed.

Keywords

Green Building, Heritage Structures, passive heating and cooling

1. Introduction

A green building is defined by World green building council (WCBC) as building that "Reduces or eliminate the negative impacts in its design, construction and operation and which can create positive impacts on the environment and climate and conserve precious natural resources along with it also improves our quality of life ". There are so many features which can make a building "Green", and these are given as follows [1]: Efficiently use of water, energy (Electricity), and other resources; Maximum use of renewable energy such as solar energy; Good indoor environmental air quality; Consideration of proper ventilation, sunlight and other environmental constraints at the time of design, construction and operation; Consideration of proper quality of life pf the occupants. The world's first green building standard was released in 1990 in the UK and in the year of 1992 UN conference promoted the idea of sustainable and green buildings. After that United States created the green building association and other countries are also started the work on green building and develop their standards such as: Hong Kong (in 1996), Taiwan (in 1999), Canada (in 2000), Singapore (in 2005) etc.

As per the survey conducted by the Johnsons Control (Ireland based multinational company), 38% of buildings in India want to get the Green Building Certification. The 4% voluntary green building certification was already achieved till 2019 as compared to 14 % global certification. The India was achieved 45% green building tenant space, 40% net zero energy carbon

44% operate of the grid, and 68& Resilience and compared to the 51%, 50%, 50% and 72% respectively global progresses. The green building drivers in energy investment decision are energy cost saving, greenhouse gas footprint reduction, increasing energy security, increase building resilience and attracting/ retaining employees [2].

Indian green building council (IGBC) had fixed a target of 10 billion square feet green building till 2022 and approximately 75% (7.17 billion square feet) of green building footprint target is already achieved till 2020 whereas the green building status in 10 top states of India is shown in figure 1. It is observed that the lowest number of green projects found in Rajasthan state and highest number of green building project found in Maharashtra state of India. The IGBC stated that the "one billion square feet Green building is saved 12 MT of CO2, 15000 GW energy and 45 Million ltr water which leads to the environmental benefits". [3]

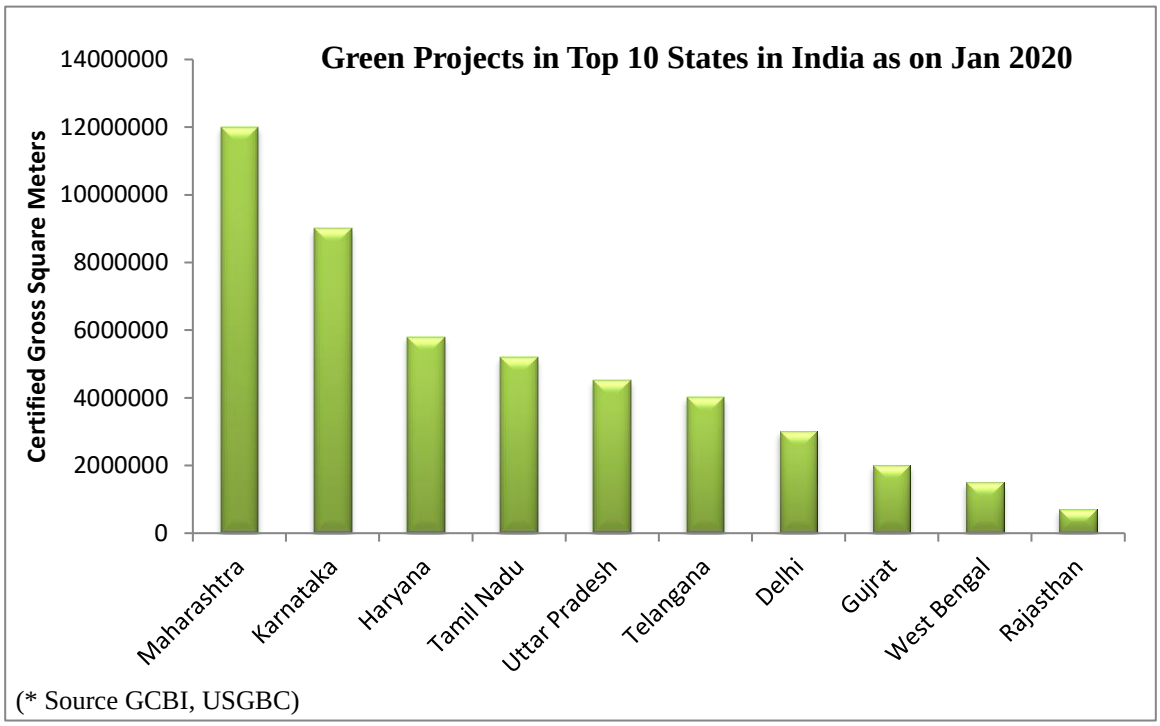

Figure 1. Green Building Projects in top 10 states in India as on Jan 2020

Gilani et al. [4] studied the green building development for sustainable environment with reference to India and also presented some name of top 50 green buildings of India as well as the key features of green buildings. M.P. et al. [5] projected the energy savings, emission reduction and health benefits of the green building. The Co-BE calculator was used to determine the pollutant emission reduction. The passive cooling of buildings and different architectural designs/modifications for green building or sustainable architecture were studied by Jain et al. [6] and Vyas et al. [7].

Lal et al. [8] studied that the conventional buildings are responsible for atleast 40% use of total energy. So many tangible benefits are accruing for the entire lifecycle of the building where green building reduces the 40-60% of electricity and 40-80% water consumption, as well as it generates less waste due to onsite applying the waste management strategies as compared to conventional building. Some of the intangible benefits are also accrues like increases air quality, daylighting marketability and puts the important role in conservation of scarce national & international resources. The building related illness and stresses caused factors are shown in figure 2, whereas all factors of BRI or SBS is occurred mainly due to low ventilation or low air change per hour (ACH) in buildings. High conventional energy consumption, conventional of non-conventional fuel

consumption in power plants, vehicle, and kitchens are also generating the sick building syndromes (SBS) it is clearly presented in five important BRI factors in figure 2 and in Green building construction/application our aim is to reduce the energy consumption in all phases [9].

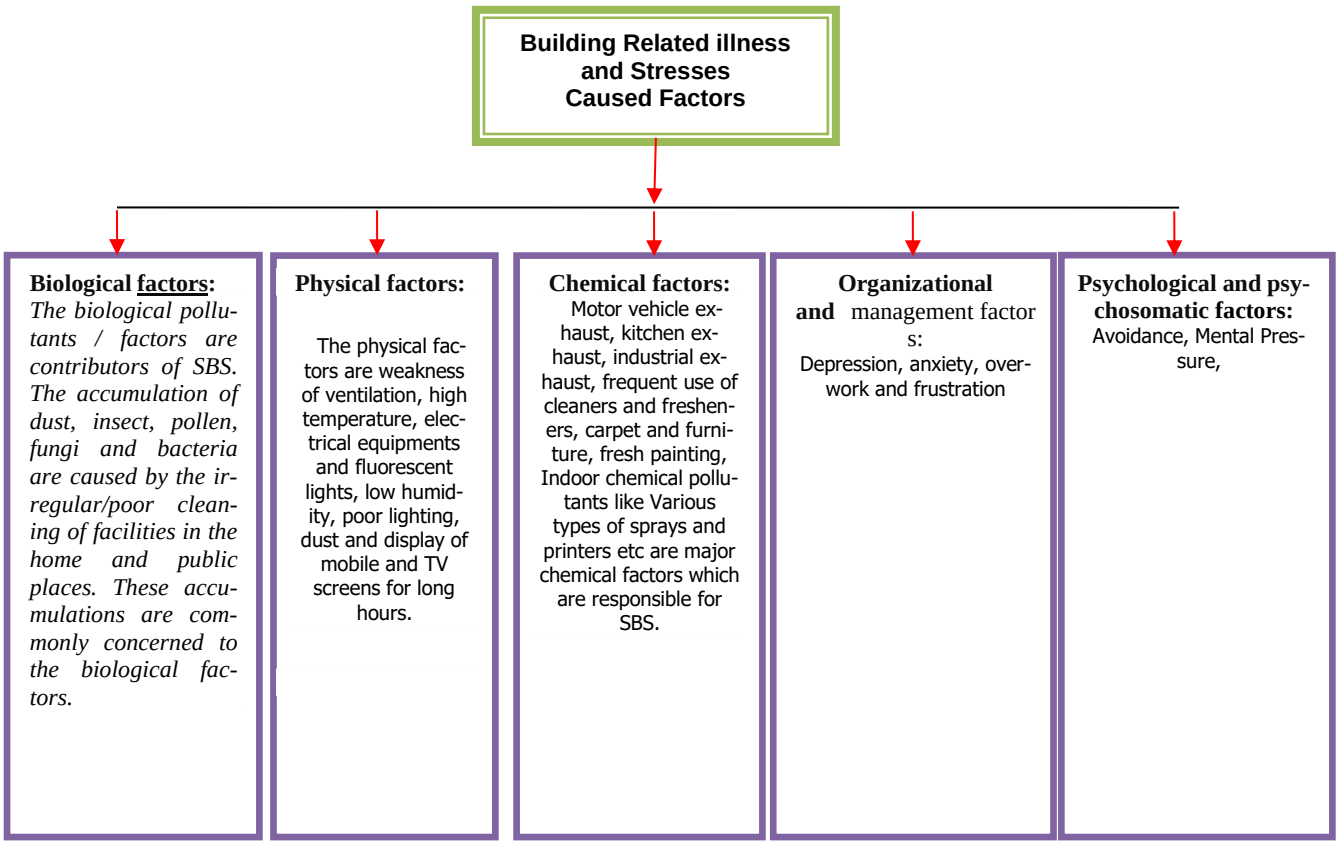

Figure 2. Building related illness and stresses caused factors [**9**]

The concept of green building is thousands year old but the worlds researchers are still working on the new era of green building certification and applications. This study is very useful for the researchers in this field

2. Martials and Methods

2.1. Introduction

A green building is compared to the conventional building and observe that "it uses less water, optimize energy efficiency, conserve natural resources, generate less waste and provide healthier space to occupants"[10]. The green building megatrends to 2020 and it consists of healthy building, solar power utilization, water conservation potential, rise of energy efficiency, net zero buildings, existing building modifications, performance disclosure, the cloud and the competition. The main criteria of a green building are the proper ventilation for which a proper Air change per hour is required

2.2. Building Ventilation

The star rating for green buildings is provided by GRIHA, which emphasizes the passive solar techniques for optimizing indoor visual and thermal comfort in buildings. The indoor air quality is to be maintained by proper ventilation system and air exchange rate. Lal et al. [11] experimentally analyzed the air change per hour (ACH) for an individual house and observed that the solar

chimney increases the ACH up to required level in the building. The ACH is the speed at which all the air inside a room is replaced by the ventilation system. The ACH required in the building sections is given in Table 1 as follows: [12]

The NBC recommended ACH for various buildings in normal condition and Covid-2 situation is shown in table-1 and it is found that the ventilation load on the building will be increasing in Covid-2 scenario. In this condition conventional energy based higher star rating ventilation equipment will be used

Table 1: The ACH as per NBC 2016 and from Covid-2 situations [12]

S. No.	Application	ACH as per NBC 2016	ACH in SARS-Covid-2 Virus scenario
For Residential Buildings			
1.	Bed room	2-4	3-5
2	Living Room	3-6	4-7
3	Kitchen	6 min	10 min
4	Gymnasium	6 min	10 min
5	Changing/ bathroom	6-10	8-12
6	Toilet	6-10	8-12
7	Corridors	5-10	6-12
8	Entrance Hall	3-5	4-6
9	Garages	6-8	8-10
10	Basement	3-10	4-12
11	Laundries	10-30	12-36
12	Lavatories	6-15	8-18
Non Residential (Office, Churches, Club, Hospital, Bakeries theatres, libraries etc.) Buildings			
1	Offices	6-10	12 Min
2	Churches	1-3	10-15
3	Club House	12 Min	18-24
4	Hospital	15-20	18-24
5	Bakery	20-30	24-36
6	Lecture Theatres	5-8	12 MIN
7	Library	3-5	12 Min
8	Banks	4-8	8-10
9	Assembly Hall	4-8	8-10
10	Dye work	20-30	24-36
11	Coffee house/bars	10-12	12-15
12	Conference room	8-12	10-15
13	Restaurants	8-12	10-15
14	Canteen	8-12	10-15
15	cinema Hall	10-15	12-18
16	Saloon	10-15	12-18
17	Dance theatre	12 Min	15 Min
18	Laboratories	6-15	8-18
19	Paint Shop	10-12	12-30
20	Recoding Control room	15-25	18-30
21	Shop/ Supermarket	8-15	10-18
22	Shoe store/Ware houses	3-6	4-8
23	Class rooms	5-7	12 Min
24	X ray room/Photo dark room	10-15	12-18
25	Studio/Recording Studio	10-12	12-15
26	Compressor Room	10-12	12-15

The number of solar chimneys can be installed over a building to improve the ventilation rate for the situations. The wall mounted solar chimney can be modified for day-night application via change of energy stored material. The number of solar chimneys can be increased according to the requirement and the cost of the mountings is very low as compared to the other applications for improving the ACH, because the recurring cost would be higher for conventional energy-based fans etc. [13-16]. Another feature of the green building is to maintain the indoor temperature as per human comfort for which researchers have prescribed the earth air tunnel and bore hole heat exchangers as well as earth heat exchangers. The applications of these application have reduced the cooling and heating load of buildings and also saved the conventional energy [17-19]. The basic diagram of chimney and EATHE integrated house is shown in figure 3.

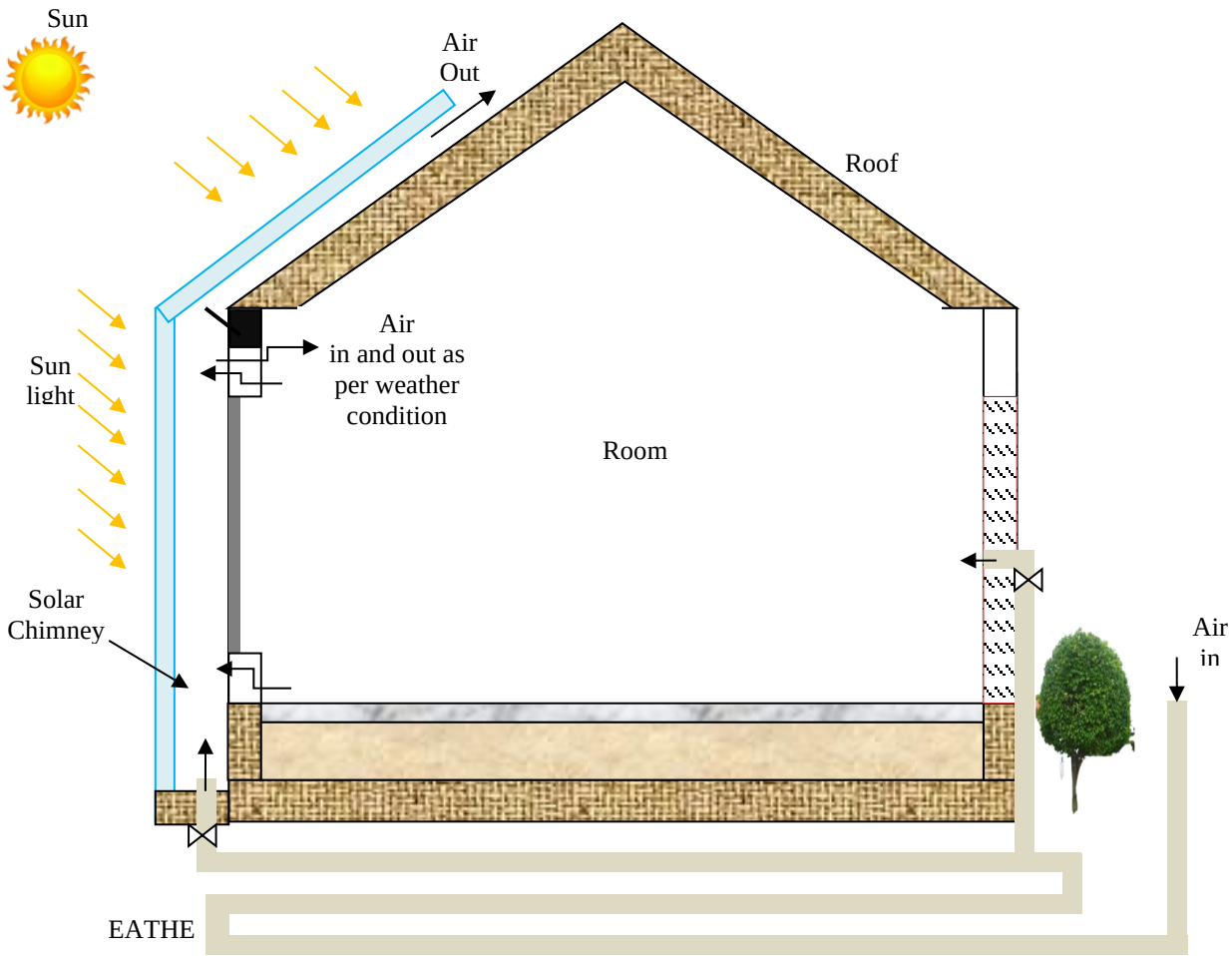

Figure 3. Solar Chimney and EATHE integrated Green Building

2.3. Building Comfort Conditioning for Green Building

The heating and cooling load accounts for highest energy consumption by buildings which increases due to vertical growth of infrastructure in India. The largest energy consumed by commercial and residential building apart from 33% industry and 28% transportation [lal et al. 2012]. The energy is consumed in lightning, heating, cooling, cooking, ventilation, washing, computer,

and refrigerator, etc. whereas space heating & cooling and lighting are the major energy contributors. The end use contribution by ventilation equipment's in USA is 6% higher than India.

The application of thermal energy is extensively utilized for the heating of building in winter. The ground source can be used for both space heating and cooling in different seasons as in peak winter and peak summer, where the maximum heating and cooling potential can be assessed by the maximum temperature different between peak ambient temperature and annual average sol-air temperature on the earth surface. The development of renewable-energy-based thermal devices can be an option for minimization of the use of conventional energy/fuel. The energy efficient passive heating and cooling devices like solar chimney, earth air tunnel and borehole heat exchangers play an important role in improving the sustainability and reduce the energy demand, as well as it helps to improve the environmental concern.

Lal et al [18] stated that the average cooling capacity of EATHE in peak summer of April and May month was calculated above 500 kWh, because of high ambient temperature as 45°C, and heating capacity of EATHE in peak winter was found more 350kWh. Similarly, the cooling and heating capacity of Borehole heat exchanger (BHE) is evaluated in peak summer and winter period as 180kWh and 150kWh respectively [19]. As compared to EATHE and BHE it was studied that the BHE found more economical than EATHE [20]. Lal et al. also studied the integrated approaches or solar chimney and EATHE as well as solar chimney and BHE and that the integrated approached produced more heating and cooling effect with the higher ventilation rate [21-22].

2.4. Building Aura and Architecture for Green Building

Everybody wants to return to a home that's full of affection, harmony and wealth. While several of us try colorful ways to achieve this, right from Poojas to Feng Shui. But have you heard of Aura scanning? Aura scanning can indicate a Person's state of mind, physical condition, vulnerable capacity and also inner characteristics [23]. The Aura photography is called Kirlian photography; it is a method that creates contact print photography using high voltage and does not require the use of camera. Basically, it is a photography technique used to capture the phenomenon of electrical coronal discharges. In the low Aura place a person feels uneasiness and anxiety in that condition the fellow member wants to move in another room immediately and feels warmth & peace.[24]

The saliva sample of various persons have been collected and checked the Aura by Aura scanner found that the aura of a healthy person is varying between 2.5 to 3 m', sick person's below 2.0 m', the aura of a person in the medical ward found 1.5-2.0 m', and aura of a person in ICU unit is 1.0-1.2 m'. The unit of Aura measurement is mannem's (m') scale in meters [25]. The Green color of plants is mainly gives harmony for Human survival, (550 htz 550 nm). The Pipal, Bargad, Tulsi and Chinese Bambu etc. all holy plants are having higher aura than other plants. The residential, office or any other Buildings aura is dependent on the sunlight or light inside the building as well as ventilation of the building but some of the researchers also stated that the building aura is also depends upon the Vastu. The ancient Indian literature on Vastu approved the direction of gate, location of bedroom, Poojasthal, Kitchen etc. They also recommended the holy plants in the buildings as well as the Geometrical and architectural design of building for positive energy/ higher aura.

2.5. Building Inputs

The building inputs are Building material at the time of construction and the daily useable utensils and energy required as recurring inputs. If a building is constructed on an old site where old building already exist than it is required to be recycle job site construction and demolition waste, protect native soils, minimize disruption of existing plants and trees, Implement construction site stormwater practices, protect water quality with landscape design and reuse /recycled content materials for landscaping, install high efficiency irrigation system, provide onsite water catchment/retention, Incorporate recycled fly ash in concrete, insulate foundation before Backfill and Use recycled content steel studs for interior framing etc. Always use LEDs as

light bulbs and star rating household appliances [26-27]. Gupta et al. [28] studied the daylight in a college classroom and it was observed that daylight pipe can be used for the building lights to meet out the required Lux. The solar PV systems are the best solution for all types of buildings and its Payback period is reduced by less than 4 years. Lal et al. [29-31] designed SPV system for a government school and submersible pump for public water supply and presented its techno-economic analysis also. If the requirement of the house is very low, then thermoelectric cooler can be used for chilling the water and some other small application [32]. By these methods the conventional energy consumption can be minimized and it leads to the green building concept.

2.6. Star Rating for Green Building

Green building rating system is an assessment tool to determine the environmental performance of a building through its life cycle. Green building rating system is an assessment tool to determine the environmental performance of a building through its life cycle. The IGBC is responsible for promoting green building concept in India. There are two rating systems used for green building rating in India, such as Leadership in Energy & Environmental Design (LEED) and Green rating for integrated habitat assessment (GRIHA) national rating system. LEED India was formally launched in 2006 but it became operational form from January 2007. It adopted local India codes like Central Pollution Control Board (CPCB), Ministry of Environmental and Forest (MoEF), Energy conservation building code (ECBC) and Indian standards (IS) for more emphasis on water conservation. It means LEED promotes a building approach to sustainability by recognizing performance in area of water saving, energy efficiency, indoor air quality and sustainable site development [33]. The LEED provides four type of certification like Certified; silver, gold and platinum and their points are shown in Table 2. The GRIHA emphasizes passive solar techniques for optimizing indoor visual and thermal comfort and it provides five-star rating systems which also shown in table 2.

Table 2. Green Building Rating and Point system of LEED and GRIHA [33]

LEED India Certification for New Construction			**LEED India Certification for Core or Cell**		
S.No.	Certification Level	Points	S.No.	Certification Level	Points
1.	Certified	26-32	1.	Certified	23-27
2.	Silver	33-38	2.	Silver	28-33
3.	Gold	39-51	3.	Gold	34-44
4.	Platinum	52 or more	4.	Platinum	45-61
LEED India Certification for Individual homes			**LEED India Certification for Multi-dwelling units**		
S.No.	Certification Level	Points	S.No.	Certification Level	Points
1.	Certified	32-39	1.	Certified	30-37
2.	Silver	40-46	2.	Silver	38-44
3.	Gold	47-54	3.	Gold	45-52
4.	Platinum	55-74	4.	Platinum	52-75
LEED India Certification for Green Factory Building			**GRIHA Ratings for Buildings**		
S.No.	Certification Level	Points	1.	Rating	Points
1.	Certified	51-60	2.	One Star	50-60
2.	Silver	61-70	3.	2 Star	61-70
3.	Gold	71-80	4.	3 Star	71-80
4.	Platinum	81-100	5.	4 Star	81-90
			6.	5 Star	91-100

2.7. Important Green Building in India

The certification of green building is very low and which is less than 4%. The important certified green buildings are shown in Table 3, India has accorded third ranks for rating of green building in 2021.

Table 3. Certified Green Buildings in India [34-35]

S.No.	Name of Building	Rating	S. No.	Name of Building	Rating
1.	Suzlon One Earth, Pune	Platinum	16.	DLF Cyber City project	Platinum
2.	Rajiv Gandhi International Airport (RGIA), Hyderabad	Silver	17.	Ankit Gems Diamond Factory, Surat	Platinum
3.	CII- Sohrabji Godrej Green Business Centre, Hyderabad	platinum	18.	DLF Retail projects Avenue Mall	Platinum
4.	Infosys Limited, Mysore	Platinum	19.	ITC Windsor at Bangalore	Platinum
5.	Infinity Benchmark, Kolkata	Platinum	20.	ITC Grand Chola, Chennai.	Platinum
6.	I-Gate Knowledge Centre, Noida	platinum	21.	The Chanakya	O+M
7.	Wipro Technologies, Gurgaon	Platinum	22.	Wipro Campus, Greater Noida	Gold
8.	ITC Green Centre, Gurgaon	Platinum	23.	Knowledge Boulevard, Noida	Gold
9.	Olympia Tech Park, Chennai	Gold	24.	Spectral Services, Hyderabad	Gold
10.	CRISIL House, Mumbai	Platinum	25.	Windsor corporate tower pvt. ltd.	Gold
11.	Indira Paryavaran Bhawan Delhi	Platinum	26.	EON Free Zone - POD E	Gold
12.	ITC Maurya Hotel, New Delhi	Platinum	27.	AIPL Business Club	Gold
13.	Infosys, Hyderabad	Platinum	28.	Hyatt Andaz	Gold
14.	Cisco Building, Bangalore	Platinum	29.	Nokia Gurgaon	Gold
15.	CESC House in Kolkata	Gold	30.	IT Building G2, Kharadi, Pune	Gold

2.8. Green Building and Technological Advancement

The architectural advancement to improve the sunlight and ventilation in each room or space is needed. The whole technological advancement towards green building is summarized into these points as: Siting and Structure Design Efficiency (Sustainable design), Energy Efficiency (Low energy house and zero energy building), Water Efficiency (Water conservation), Material Efficiency (Sustainable Architecture), Indoor Environmental quality enhancement (Indoor air quality), Operational and maintenance optimization, waste reduction, Reduce impact onto electricity network. [36-37].

3. Conclusion

A thorough study on green building design concept has been presented in this study and concluded that the green building is full of warmth, harmony and prosperity. It is a fully ventilated, comfort conditioned and full of green with plants and trees. The green building applies technological advancement for energy saving, water and sewage management system, sustainable

design, and material efficiency. There is no waste in green building and it is will help to improve the safe and clean environment

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