GREEN ARCHITECTURE FOR ENVIRONMENTAL SUSTAINABILITY

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ABSTRACT

"A nation that destroys its soil destroys itself" – said Franklin D.Roosevelt

Is integrating technologies at our finger tips instigating us to forget environmental ethics? Yes! As the magnitude of human impacts on the ecological systems of the planet becomes apparent, there is an increased realization of the intimate connections between these systems of technologies and our ecosystem. The unprecedented environmental changes have challenged scientists to develop better technologies which enable us to move towards a more sustainable biosphere. Hence, the environmental problems we confront today call for more environmentally benign technologies. These include comprehensive information, understanding and technologies which are ecologically sound, economically feasible and socially just. By doing so the idea of keeping the environment as pristine as naturally possible is achieved. As a result, time demands that we address the problems and issues concerning the ***three pillars of sustainability - environment, economy, and society*** *through the active participation of science, technology and engineering. From the civil engineering field we choose green architecture as a narrower aspect of this vast topic for presentation.* ***Green architecture*** *is one such technology paying due respect to environment, economy and society at the same time. This paper dwells on the idea of structures built and designed using green process and materials that are environmentally responsible and resource-efficient throughout a structure's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition; the three thumb rules for a building to be green; construction waste reduction etc.Sustainable architecture uses a conscious approach to energy and ecological conservation in the design of the built environment, the prime motive being minimal impact of the built environment byefficiently using energy, water, and other resources ,protecting occupant health and improving employee productivity and reducing waste, pollution and environmental degradation.*

I. INTRODUCTION

Time demands a change. It is high time that we switch over to technologies that are sustainable because as the magnitude of human impacts on the ecological systems of the planet becomes apparent, very lately there has been an increased realization of the intimate connections between these systems and human health, the economy and social justice. Not for long is our Mother earth going to tolerate the atrocities committed on her by humans today, trying to achieve everything around with least concern for the future generations. Hence, its time that we move on with technologies and science that will give due concern for our future and the Earth. And this is a challenge indeed. New fundamental research, faster and more effective transmission of new and existing knowledge to policy and decision-makers, and better communication of this knowledge to the public will all be required to meet this challenge. But the field of civil engineering has already bloomed out with ideas, to meet this challenge in the construction industry, which is contemporarily widely accepted. It's the idea of Green Architecture.

Green architecture, Integrating Landscape and Architecture to make cities delightful. The more livable our cities, the more sustainable they can be. It is an endogenous system with connectedness and mutual dependence between the built environment and nature. It aims at achieving the three pillars of sustainability –environment, economy and society. Hence, 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.

II. SIGNIFICANCE OF GREEN ARCHITECTURE

2.1 Environmental benefits

- Helps reduce the impacts of natural resource consumption

2.2 Economic benefits

- An integrated design allows high benefit at low cost by achieving synergies between disciplines and between technologies and
- Reduce operating costs by helping lower utility costs significantly

2.3 Health and safety benefits

- It enhances occupant comfort and health

2.4 Community benefits

- Helps minimizestrain on local infrastructures and improve quality of life

This is where the significance of green architecture lies. Through the implementation of green architecture environmental, economic, health and community issues can be targeted and addressed.

III. SETTING GREEN GOALS AND OBJECTIVES…

Once the decision to build green has been made, one of the first steps in the green design process is to establish firm environmental goals for the project. This is often done during what is called a goal setting or targeting session. During this session, it is important to set specific measurable goals for things like energy efficiency, water conservation, on-site treatment of rain water and storm water, material and resource management, construction waste management, and to assign responsibility for meeting these goals to specific members of the design team.

IV. BUILDING A GREEN TEAM…

Hiring a design team with prior green design experience is highly desirable, but not essential provided that the design team is augmented with architects or engineering consultants who do have experience in green building and site design principles and technologies. The collective knowledge, experience, and dedication of the design team will determine the overall success of the green project. All members of the green team should participate in the project goal setting session. Once the goal setting process has been completed it may become obvious that meeting certain goals may require expertise that lies outside the current design team. Specialized consultants may need to be engaged for specific elements of the design and construction process or to oversee all elements of the green design program. These specialists will be able to bring new ideas and solutions to the table for consideration and should be included in the project as early as possible.

V. A GREEN DESIGN FOR A STRUCTURE

Building a green building is not just a matter of assembling a collection of the latest green technologies or materials. Rather, it is a process in which every element of the design is first optimized and then the impact and interrelationship of various different elements and systems within the building and site are re-evaluated, integrated, and optimized as part of a whole building solution. For example, interrelationships between the building site, site features, the path of the sun, and the location and orientation of the building and elements such as windows and external shading devices have a significant impact on the quality and effectiveness of natural day lighting. These elements also affect direct solar loads and overall energy performance for the life of the building. Without considering these issues early in the design process, the design is not fully optimized and the result is likely to be a very inefficient building. This same emphasis on integrated and optimized design is inherent in nearly every aspect of the building from site planning and use of on-site storm water management strategies to envelope design and detailing and provisions for natural ventilation of the building. This integrated design process mandates that all of the design professionals work cooperatively towards common goals from day one.

5.1 Five elements of a green building

- Sustainable Site Design
- Water Conservation and Quality
- Energy and Environment
- Indoor Environmental Quality and
- Conservation of Materials and Resources.

VI. SUSTAINABLE SITE DESING

6.1 Key Principles:

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, 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.

6.2 Key Strategies and Technologies

- Make more efficient use of space in existing occupied buildings, renovate and re-use existing vacant buildings, sites, and associated infrastructure and consider re-development of brownfield sites. Design buildings and renovations to maximize future flexibility and reuse thereby expanding useful life.
- When new development is unavoidable, steer clear of sites that play a key role in the local or regional ecosystem. Identify and protect valuable greenfield and wetland sites from development.
- Recognize that allowing higher density development in urban areas helps to preserve green space and reduce urban sprawl. Invest time and energy in seeking variances and regulatory reform were needed.
- Evaluate each site in terms of the location and orientation of buildings and improvements in order to optimize the use of passive solar energy, natural day lighting, and natural breezes and ventilation.
- Make best use of existing mass transit systems and make buildings and sites pedestrian and bike friendly, including provisions for safe storage of bicycles. Develop programs and incentives that promote car-pooling including preferred parking for commuters who carpool. Consider making provisions for re-fuelling or recharging alternative fuel vehicles.
- Help reduce the urban heat island effect by reducing the building and site development footprint, maximizing the use of pervious surfaces, and using light coloured roofs, paving, and walkways. Provide natural shading of buildings and paved areas with trees and other landscape features.
- Reduce impervious areas by carefully evaluating parking and roadway design. Pursue variances or waivers where local ordinances may unintentionally result in the over-design of roadways or parking.
- Optimize the use of on-site storm water treatment and ground water recharge. Minimize the boundaries of the construction area, avoid needless compaction of existing topsoil, and provide effective sedimentation and silt control during all phases of site development and construction.
- Use landscape design to preserve and restore the region’s natural habitat and heritage while emphasizing the use of indigenous, hardy, drought resistant trees, shrubs, plants and turf.
- Help reduce night-time light pollution by avoiding over-illumination of the site and use low cut-offexterior lighting fixtures which direct light downward, not upward and outward.

VII. WATER QUALITY AND CONSERVATION

7.1 Key Principles:

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 grey water.

7.2 Key Strategies and Technologies:

- Recognize that the least costly, least time consuming and most environmentally preferable design for site and storm water management is often the one in which the design of buildings and site improvements respect the existing natural flows and features of the land, instead of designing the building and site improvements with total disregard for the site, which results in needless, extensive, disruptive, costly and time consuming excavation and earthmoving.

- Conduct a thorough site assessment and strategically locate buildings and site improvements so as to preserve key natural hydrological features. Special effort should be made to preserve areas of the site that serve as natural storm water retention and ground water infiltration and recharge systems. Preserve existing forest and mature vegetation that play a vital role in the natural water cycle by absorbing and disbursing up to 30% of a site's rainwater through evapo-transpiration.
- Minimize the building's footprint, site improvements and construction area, and minimize excavation, soil disturbance and compaction of existing topsoil as this soil in its natural uncompact state serves a vital role in absorbing and storing up to 80% of natural rainfall until it can be absorbed by vegetation or enter the site's natural sub-surface ground water system.
- Design and locate buildings and site improvements to optimize use of low-impact storm water technologies such as bio-retention, rain gardens, open grassy swales, pervious bituminous paving, pervious concrete paving and walkways, constructed wetlands, living/vegetated roofs, and other technologies that support on-site retention and ground water recharge or evapo-transpiration. Storm water that leaves the site should be filtered and processed naturally or mechanically to remove trash and debris, oil, grit and suspended solids. Use "hold and release" technologies such as dry retention ponds only as a last resort as these technologies do not preserve the natural water cycle, have little or no benefit in terms of ground water recharge and result in needless additional site disturbance.
- Establish a water budget for the building and implement a design that minimizes the use of potable water by using low-flow plumbing fixtures and toilets and waterless urinals. Harvest, process and recycle rainwater, site storm water, and building grey water and identify appropriate uses within the building and site. Use on-site treatment systems that enable use of rain water for hand washing, grey water for toilet flushing, rain and storm water for site irrigation, cooling tower make-up and other uses.
- Conserve water and preserve site and ground water quality by using only indigenous, drought resistant and hardy trees, shrubs, plants and turf that require no irrigation, fertilizers, pesticides or herbicides.

VIII. ENERGY AND ENVIRONMENT

8.1 Key Principles:

Minimize adverse impacts on the environment (air, water, land, natural resources) through optimized building siting, 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.

8.2 Key Strategies and Technologies:

- Optimize passive solar orientation, building massing and use of external shading devices such that the design of the building minimizes undesirable solar gains during the summer months while maximizing desirable solar gains during winter months.
- Optimize building orientation, massing, shape, design, and interior colours and finishes in order tomaximize the use of controlled natural day lighting which significantly reduces artificial lighting energy use thereby reducing the buildings internal cooling load and energy use. Consider the use of light shelf technology.
- Use high performance low-e glazing, which can result in significant year round energy savings.Consider insulated double glazing, triple glazing or double pane glazing with a suspended low-e film.Selective coatings offer optimal light transmittance while providing minimal solar gain and minimal heat transmission. Window frames, sashes and curtain wall systems should also be designed for Optimum energy performance including the use of multiple thermal breaks to help reduce energy use.
- Optimize the value of exterior insulation and the overall thermal performance of the exterior envelope assembly. Consider advanced/high performance envelope building systems such as structural insulated panel systems (SIPS) and insulated concrete form systems (ICF's) that can be applied to light comme00wrcial and institutional buildings. SIPS and ICF's and other thermally "decoupled" envelopae systems will offer the highest energy performance.
- Use energy efficient T-8 and T-5 bulbs, high efficiency electronic ballasts, and lighting controls. Consider using indirect ambient lighting with workstation based direct task lighting to improve light quality, reduce glare and improve overall energy performance in general office areas. Incorporate sensors and controls and design circuits so that lighting along perimeter zones and offices can be switched off independently from other interior lights when daylighting is sufficient in perimeter areas.
- Use state-of-the art, high efficiency, heating, ventilation and air conditioning (HVAC) and plumbing equipment, chillers, boilers, and water heaters, etc. Use variable speed drives on fan and pump motors. Use heat recovery ventilators and geothermal heat pump technology for up to 40% energy savings.
- Avoid the use of HCFC and Halon based refrigeration, cooling and fire suppression systems. Optimize the use of natural ventilation and where practical use evaporative cooling, waste heat and/or solar regenerated desiccant dehumidification or absorption cooling. Identify and use sources of waste energy.
- Use Energy Star certified energy efficient appliances, office equipment, lighting and HVAC systems.
- Consider on-site small-scale wind, solar, and/or fuel cell based energy generation and co-generation. Purchase environmentally preferable "green" power from certified renewable and sustainable sources.

IX. INDOOR ENVIRONMENTAL QUALITY

9.1 Key Principles:

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, and thermal comfort, access to natural ventilation and day lighting, and effective control of the acoustical environment.

9.2 Key Strategies and Technologies:

Use building materials, adhesives, sealants, finishes and furnishings which do not contain, non-eco-friendly materials, generate or release any particulate or gaseous contaminants including volatile organic compounds.

- Maximize the use of natural daylighting. Optimize solar orientation and design the building to maximize penetration of natural daylight into interior spaces. Provide shades or daylight controls where needed.
- Maximize the use of operable windows and natural ventilation. Provide dedicated engineered ventilation systems that operate independently of the buildings heating and cooling system. Ventilation systems should be capable of effectively removing or treating indoor contaminants while providing adequate amounts of fresh clean make-up air to all occupants and all regions of the building. Monitor indoor air conditions including temperature, humidity and carbon dioxide levels, so that building ventilation systems can respond when space conditions fall outside the optimum range.
- Provide a smoke free building. When smoking must be accommodated, provide completely dedicated smoking areas are physically isolated, have dedicated HVAC systems, and remain under negative pressure with respect to all adjoining spaces. Assure that air from smoking areas does not get distributed to other areas of the building does not re-enter the building through doors or vestibules, operable windows, or building fresh air intakes. Locate outdoor smoking areas so that non-smokers do not have to pass through these areas when using primary building entrances or exits.
- Maximize occupant health, comfort and performance by providing occupants with individual space/zone control of heat, ventilation, cooling, day-lighting and artificial lighting whenever possible.

X. MATERIALS AND RESOURCES

10.1 Key Principles:

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.

10.2 Key Strategies and Technologies:

Optimize the use of engineered materials which make use of proven engineering principles such as engineered trusses, composite materials and structural systems (concrete/steel, other…), structural insulated panels (stress skin panels), insulated concrete forms, and frost protected shallow foundations which have been proven to provide high strength and durability with the least amount of material.

- Identify ways to reduce the amount of materials used and reduce the amount of waste generated through the implementation of a construction waste reduction plan. Adopt a policy of "waste equals food" whereby 75% or more of all construction waste is separated for recycling and used as feedstock for some future product rather than being landfilled. Implement an aggressive construction waste recycling program and provide separate, clearly labelled dumpsters for each recycled material. Train all crews and subcontractors on the policy and enforce compliance.
- Identify ways to use high-recycled content materials in the building structure and finishes. Consider everything from blended concrete using fly ash, slag, recycled concrete aggregate, or other admixtures to recycled content materials such as structural steel, ceiling and floor tiles, carpeting, carpet padding, sheathing, and gypsum wallboard. Consider remanufactured office furniture and office partition systems, chairs and furniture with recycled content or parts.
- Design building envelope and environmental systems that not only treat air temperature and provide adequate ventilation, but which respect all of the environmental conditions which affect human thermal comfort and health, including the mean radiant temperature of interior surfaces, indoor air humidity, indoor air velocity, and indoor air temperature. Following these principles and providing a building that is also responsive to seasonal variations in desirable indoor humidity levels, air velocity, and mean radiant temperatures can also result in significant energy savings as improved occupant comfort results in less energy intensive operation of the buildings air-side heating and cooling system.
- Explore the use of bio-based materials and finishes such as various types of agriboard (sheathing and or insulation board made from agricultural waste and by-products, including straw, wheat, barley, soy, sunflower shells, peanut shells, and other materials). Some structural insulated panels are now made from bio-based materials. Use lumber and wood products from certified forests where the forest is managed and lumber is harvested using sustainable practices. Use resource efficient engineered wood products in lieu of full dimension lumber which comes from older growth forests.
- Evaluate all products and systems used for their ability to be recycled when they reach the end of their useful life. Preference should be given to products and systems that facilitate easy, non-energy intensive separation and recycling with minimal contamination by foreign debris.
- Recognize that transportation becomes part of a product or building materials embodied energy. Where practical, specify and use locally harvested, mined and manufactured materials and products to support the regional economy and to reduce transportation, energy use and emissions.

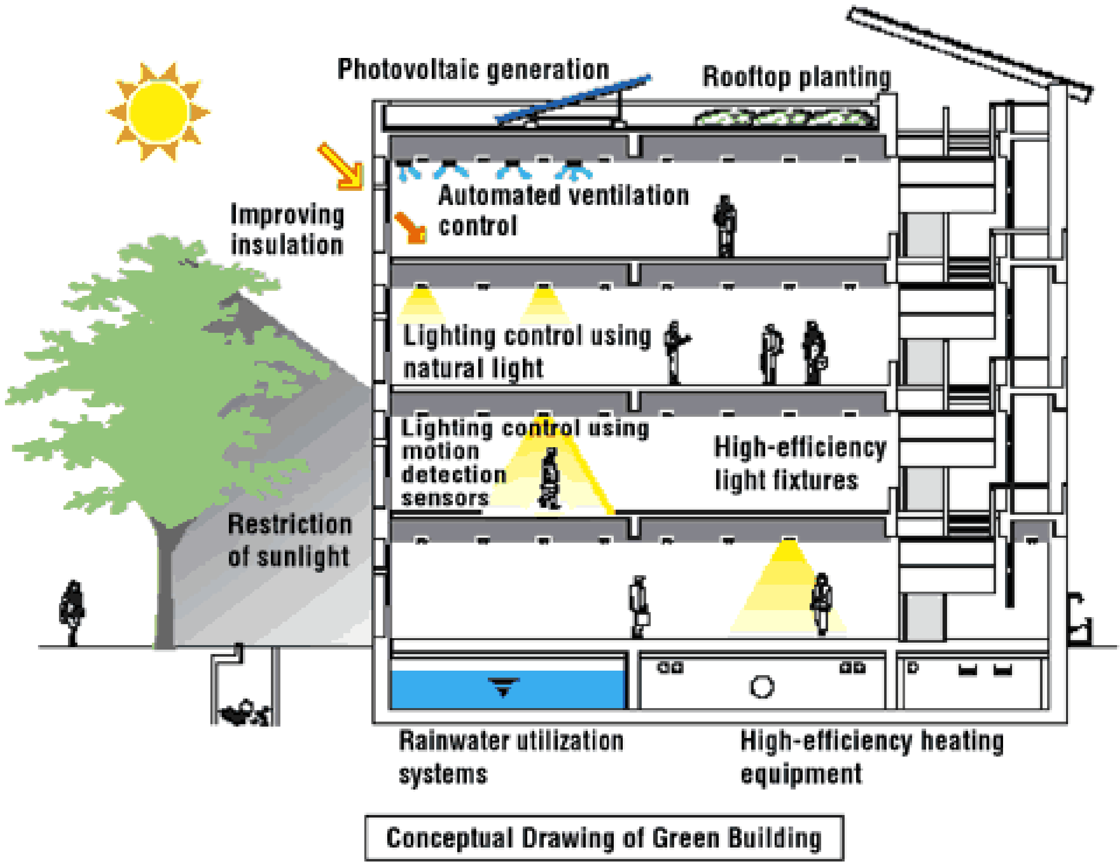

Figure I Conceptual Drawing of Green Building

XI. BREAKING THE MYTH THAT ALWAYS GREEN COSTS MORE

While many green materials and technologies do cost more, it has been demonstrated that many green strategies and technologies actually cost the same and some even cost less than traditional "not-so-green" technologies. By blending the right mix of green technologies that cost less with green technologies that cost the same or slightly more, it is possible to have a very green building project that costs the same as a conventional one. Often the key to a cost effective green building and site design lies within the interrelationships and associated cost and performance trade-offs that exist between different building systems. For example, the use of high performance windows and window frames increases the first cost of the building envelope, however the resulting reduction in the size and cost of the buildings heating and cooling system more than offsets the added cost of the better glazing system. The result is a building that has a comparable or perhaps even a lower first cost, a higher comfort level, lower energy use, and lower energy bills and operating cost for the life of the building.

It is critical to make the decision to build a green building early in the design process in order to maximize the green potential, minimize redesign, and assure the overall success and economic viability of the green elements of the building project. Making a commitment to build green and establishing firm environmental objectives for the project must be done as early as possible because opportunities for incorporating green technologies and design solutions become less and less available and increasingly costly to implement as the project design and construction process progresses.

XII. HOW TO CERTIFY A GREEN STRUCTURE?

LEED® (U.S. Green Building Council's Leadership in Energy and Environmental Design)is an internationally recognized system that measures how well a building or community across all the metrics that matters most: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. It is a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes and neighborhoods.

Developed by the U.S. Green Building Council (USGBC), LEED is intended to help building owners and operators be environmentally responsible and use resources efficiently. Proposals to modify the LEED standards are offered and publicly reviewed by the USGBC's almost-20,000 member organizations.

Started in 1998, LEED standards have been applied to more than 7,000 projects in the United States and 30 countries, covering more than 1.5 billion square feet (140 km^2) of development area.

Under LEED 2009, there are 100 possible base points distributed across six credit categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design. Four additional points may be received for Regional Priority Credits, and six additional points for Innovation in Design.

Buildings can qualify for four levels of certification:

- **Certified:** 40–49 points
- **Silver:** 50–59 points
- **Gold:** 60–79 points
- **Platinum:** 80 points and above

Some examples for green certified structures are

- The Taipei 101 is the tallest and largest green building of LEED Platinum certification in the world since 2011.
- Abad Nucleus Mall at Maradu, Kochi is India's first LEED Gold certified mall.

XIII. QUESTIONNAIRE AND SURVEY ANALYSIS

A questionnaire was distributed among some students of our college. This was also accompanied by a survey which was conducted to find out the number of homes in our society which took effective initiative to implement green ideas at their homes efficiently. As a result of this process we were able to come to the conclusion that most homes now consisted of a garden, backyard or a green balcony in case of flats. Some homes used solar panels for heating water instead of depending on electricity. Also many homes especially those in the countryside followed the principle of constructing a compost in their backyard for the efficient use of the kitchen waste. Contemporary home designs made it a point to include more green in the interior of homes as well as in the patio with more of bamboo based furniture and glass fillings. However no one is ready to completely go green but time could show positive results with more of green based structures coming into our surroundings.

XIV. CONCLUSION

In reality, the only way to build a secure world is to change both that world and our way of thinking about it. Obviously, there are many steps that we can and should take now, such as better surveillance, better detective methods, hardened infrastructure, improved methods for protecting data, a better understanding of people living in different situations, and more secure ways of dealing with nuclear materials. But we also must address the need for constant supplies of renewable energy and reduce our dependence on both foreign and domestic sources of oil, coal, and natural gas, putting high priorities on both energy conservation and alternative sources of energy. The technology to accomplish this is available, and the economic and security advantages that would accrue to the nation are enormous

Having broken the myth that always green costs more, it is certainly in our hands to make the right decision to build green. Having known the positives and merits about green it would be wonders if we could implement green in every structure constructed today. Having the apt team of green members from all fields like architects, structural designer, contractor and the labourers would complement the upbringing of a green structure. The sole need of the hour is to try to adopt and merge this wonder colour green in every aspect of our life especially something like our homes to make a successful culmination of aesthetics, comfort of resident , health and above all a self-satisfaction of being loyal to Mother Earth. And if that is done it would be the greatest commitment we have committed to our society and environment.

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