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Review Paper

A Review on Environmental Architecture and Landscaping for Sustainable Development

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ABSTRACT

Sustainable architecture or green buildings have become the common interest of many disciplines in the recent years because the construction is basically in accordance with the environmentally friendly principles. The art of designing and constructing houses, buildings, establishments for the purposes of housing, recreation, a place for communities to meet, education etc. requires thorough understanding about the landscape and how sustainable it would be. In this paper, a thorough review and analysis of buildings which generate energy, conserve and protect environment using biodegradable materials, algal and bacterial based facades, solar energy, creation of natural biomes, cloud forest etc. was done. It is an attempt to allow people to re-imagine the basic imaginations of architecture; but with an exception, that all the projects highlighted here are helping to protect and preserve the environment in one way or the other ultimately leading to sustainable development for sustainable cities at a global level. Green architecture reduces the harm done to the environment through emission, pollution, wastage of components, indoor air quality and to human health as well.

Introduction

Sustainable ecosystems connect the environment with its organisms and that spatial connectivity between organism and environment makes ecology an excellent model for sustainable design (Bergman, 2012). Although this paper focuses mainly on Environmental Architecture which is the need of the hour, it also points out the differences between environmental architecture, landscaping and the blur that exists in between. According to Fredrick R. Bonci, founding principal, LaQuatraBonci Associates, *"Landscape architecture is truly an art that integrates the idea of the built environment with nature, and most importantly, how it relates to the individual."* (Foster, 2010). Essentially, while planning to work on an outdoor space, it is either to make it environmentally friendly or friendlier for outdoor activities. The many examples include Central park in New York, Yellowstone national park, USA, more locally, Cubbon park and Lalbagh botanical garden in Bangalore. Environmental Architecture can be defined as the designing of structures, either for residential or commercial purposes, in order to minimize the otherwise obstruction caused to environmental processes. Environmental architecture should have more to do with creating rather than the planned landscaping. Environmental architecture is confined to a relatively shorter area with assured outcomes with minimum to no variations, whereas, Landscaping can be confined to your garden in your house or to a park as big as Central park which has an area of 3.14km^2. The outcomes of landscaping vary according to seasonal as well as diurnal variations.

Landscaping, as important as it is, not only in providing healthy outdoor spaces, but also in maintaining the immediate weather and requires environmental architecture. The exponential rise in population, the flocking of the population in the *"big cities"*, the increasing living as well as environmental stress that said population exerts, need to be dealt with swiftly, and as efficiently as possible, which, without proper planning could lead to local as well as global catastrophes. Environmental architecture is the solution to this issue at a global level. This review is a thorough analysis on various environmental architectural establishments and the ways in which they help to uplift, or preserve the immediate

environmental conditions ultimately leading to a sustainable future. The establishments listed below were chosen for their inventiveness and efficiency, but it's vital to remember that any effort, no matter how small, is valuable and necessary in these times.

Materials and methodology

Sustainable environmental architectural designs

The following are a few of the numerous marvels in the field of architecture around the world. These green buildings have set the bench mark and continue to encourage aspiring architects to push the boundaries of what architecture should be and what architecture should do.

1) Biq house hamburg, Germany

Designed by Arup, SSC Strategic Science Consultants and Splitterwerk Architects in Hamburg, Germany, is the world's first algae-based bio-reactive-façade. The sun-facing sides of the building have a second outer shell set into the façade itself. Within this shell, microalgae – tiny plants, most no larger than bacteria – are produced. They allow the house to generate its own energy. The only thing that the algae have to do is grow. A separate water circuit running through the façade supplies them with liquid nutrients and carbon dioxide on a continuous basis. The algae can photosynthesize and grow with the help of sunlight. This is the world's first façade of its kind, and it employs cutting-edge energy and environmental technology. The microalgae used in the facades are grown in 2,5m x 0,7m flat panel glass bioreactors. A total of 129 bioreactors have been installed on the four-story residential building's south west and south east faces (Architonic, 2013). They also provide shade and control light. Inside, the living concept aims to maximize efficiency for daily life and provides a glimpse into future urban life. The BIQ is a highlight of the "The Building Exhibition within the Building Exhibition" thanks to its innovative living concept, futuristic exterior, and "intelligent" algae façade (IBA Hamburg today, 2013).

Fig 1: BIQ House, Hamburg, German

2) Farming Kindergarten biên hòa, vietnam

Constructed by VTN Architects, this building is designed for the children of the factory workers of a big shoe company that it is located beside. This building acts as a continuous green roof acting as an extensive playground, providing food and farming experience to the children as they play and learn at the same time. The roof has a triple-ring shape encircling three courtyards in between. The roof lowers at a few points to provide access where vegetables and other plants are grown in order to teach the children the importance of farming. The roof uses recycled factory to irrigate the farms. The combination of local materials (ex. Bricks, tiles) and low-tech construction methods are applied, hence not only reducing the environmental impact but also supporting the local industries (Archdaily, 2014).The windows that are placed on both sides of the walls allow for sunlight to enter giving natural lighting as well as natural ventilation which along with the cooling effect of the roof makes the building air-con friendly even though Vietnam is located in harsh tropical climate.

Fig 2: Farming Kindergarten, Bien Hoa, Vietnam with continuous green roof.

3) power Hyderural India

power HYDE/ Billion Bricks Homes is the world's first carbon negative, self-financing home for the homeless for the 200 million plus rural homeless that live in India. This project presents the opportunity to shape the future, where one can be a homeowner while contributing to the climate change, positively. It does so by reducing cost by using local tools helping the environment and by utilizing a solar panel as a roof which not only generates electricity but also is resistant to all climates. The solar panels generate enough electricity such that each home could sell the excess energy and have a sustainable income to support the family. Each home is expandable, classified into 3 phases, phase 1- floor planning, phase 2- horizontal expansion, phase 3- vertical expansion, allowing for personal requirements to be met (Architecture brio, 2019).

Fig 3: Billion bricks homes, India

Fig 4: Solar panels generating electricity

4) 8-HOUSE Copenhagen, Denmark

Designed by the architectural firm BIG, this bow shaped building is an architectural feat combining both housing and commerce with the apartments on the higher floors benefitting from the sunlight and the clean air while the lower floors are for the offices that merge into the life on the street. This building has a raised north east end and a lowered south west end in order to provide unobstructed sunlight to the apartments. The roof, which is continuous, along with being a green roof, is also a cycling pathway owing to the Danish cycling culture (Modern Green Structures &Architecture).

Fig 5: 8-House, Copenhagen, Denmark

5)BIMA MICROLIBRARY-Taman Bima, Indonesia

It was created by the architects at SHAU as a part of their project *"100 microlibraries"* as a means to provide a space for education for both urban residents and the students. The building consists of 2 floors, the lower floor being an open space for communities to meet and interact, while the second floor houses the library which consists of at least about 60% of the book on religion, politics, economics and other common topics and the rest about 40% of textbooks for students. The library is made from up-cycled ice cream tubs which are not only environment-friendly, but act as a façade by allowing for natural lighting and ventilation through the cut holes on the ice cream tubs. Since first starting the project in 2013 and finishing this library in 2017, SHAU have gone on to make 7 more such libraries using sustainable materials creating grounds for recreation and knowledge (Hua and Kato, 2020).

Fig 6: Bima Microlibrary, Taman Bima, Indonesia made from up-cycled ice cream tubs.

Examples of environmental architecture and landscaping

1) Eden project- Cornwall,England, UK

This project located in a china clay pit in Cornwall England was designed by Grimshaw architects, completed in May 2000 and consists of two huge adjoining domes, each of which emulates a natural biome that houses thousands of plants and animals. The biomes are made from steel frames and thermoplastic, consisting of hundreds of hexagonal and pentagonal ethylene tetrafluoroethylene inflated cells. The biomes are located at the bottom of the pit, the larger one is the Tropical biome and it stimulates a rainforest environment, the largest indoor rainforest in the world, while the second biome is a Mediterranean biome, stimulating a Mediterranean environment. The Tropical biome is the larger biome and it covers 1.5 ha, is 55m tall, 100m wide and 200m long. Tropical plants like giant bamboo, rubber, coffee and banana are grown here as the temperature and moisture levels are artificially maintained. The Mediterranean biome covers 0.6 ha, is 34m tall, 65m wide and 135m long. Plants like olives, grapes and other such plants that grow in temperate and arid conditions grow here. This project is as much an architectural project as it is a landscaping project. Surely the construction of the domes are the architectural part of it, but the planned growing of tress and plants in ways to support plant and animal life to create a "biome" is the landscaping part. Projects like these serve not only as an attraction centre, but also a means for scientists to experiment with the soil, the plants, observe animals, for which they otherwise would have to go to the tropical forests to conduct.

Fig 7: *Eden Project at Cornwall, England housing tropical biomes*

2) Gardens by the Bay-Singapore

This project is located by the Marina Waterfront in Singapore, completed and opened on 29th June 2012 designed by a London based team of Wilkinson Eyre Architects. This nature park spans a total of 101 hectares and is made up of three waterfront gardens, Bay South Garden, Bay East Garden and Bay Central Garden. The south Garden is the largest of the three gardens and is consists of various attractions like the golden garden, the canopy, the flower dome, the cloud forest, the floral clock, the super tree groove, and a variety of different indigenous gardens such as Indian garden, Chinese, etc. Bay East is the second largest garden and it has a stunning view of the Singapore skyline. Bay Central garden serves as the link between Bay South and Bay East and has a 3km walkway that boats stunning views of the city. This project uses a different kind of Landscaping compared to the Eden Project. Here, the entire project is a landscaping project with environmental architectural pieces placed in specified, planned spaces. For example, the 18 super trees in the super tree groove are one of the most advanced architectural structures to exist. These trees use sunlight to make energy with different mechanisms in them to mimic the functioning of a tree. The cloud forest is another such structure that is an architectural feat.

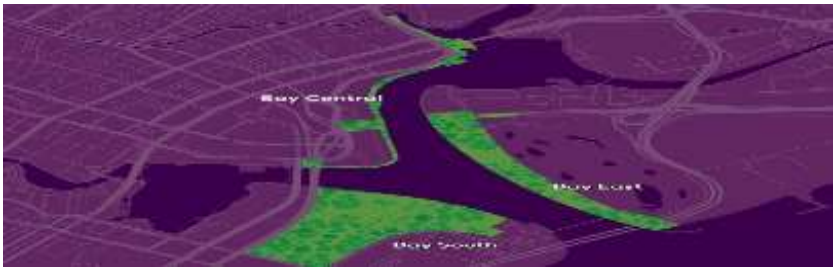

Fig 8: Gardens by the bay, Marina Waterfront in Singapore

Discussion

Architecture is going to play a major role in the ways it will change the environment, the only question to be asked is if it will make it better or worse. The examples shown in this paper are proof to show to you, the reader, that there is progress being made. Projects like Gardens by the bay and the BIQ house re-instill the belief that environmental architecture can be implemented and flourish. The need is for more projects like these in each and every city, not just the big ones, with environment being the first and main priority. It is only with the support of the people and proper funding that enables fellow

architects to not only focus of such projects but to excel and strive in it. Recently, microalgae have been extensively worked on, implementing them into various different types of structures because of their efficiency with which they can be implemented. Another method is adopted in major cities like London and Barcelona where they are having living walls. These are huge walls where plants are allowed to grow. These walls not only help make the air clean, but add a certain style to architecture and are attraction spots for tourists.

Fig 9: Barcelona, Spain

Fig 10: London, UK

Fig 11: Madrid, Spain showing live walls

As a citizen of the world, there should be steps taken to help in this fight against climate change. For starters it is the use sustainable materials for constructing houses, buildings, etc. The sustainable materials include:

- Bamboo which is considered one of the most eco-friendly material; has high tensile strength, even greater than concrete and bricks and is highly long lasting, optimum for flooring and cabinetry.
- Cork is highly flexible and strong, which reverts back to its original shape even after editing very high pressures. It is also prefect for insulation and noise absorption
- Hemp, the inner fibers of the hemp plant can be used to make hempcrete, which is used as an alternative to concrete. These blocks are strong and light and have good thermal and acoustic insulation qualities.
- Ferrock, it is a relatively new material and it is made from materials like steel dust and iron rock leftovers from industries. This material is stronger than concrete. It traps and absorbs carbon dioxide as a part of its hardening and drying process making it a carbon neutral option.

Incase these materials are not an option, the least one can do is the use of precast concrete slabs. These slabs are made in industries and are then transported to the site location. This way the concrete is properly cured in controlled environments making the concrete sturdy and strong compared to the fluctuating weather in the sites. This way a lot of the waste can be efficiently managed rather than the cement dust fly up into the air and become a part of the environment. A rather new method/scale has been implemented in London called the Urban Greening Factor (UBF). The Urban Greening Factor is a tool to evaluate the quality and quantity of Urban greening. It enables major developments to demonstrate how they have included urban greening as a fundamental element of site and building design in order to meet to meet London Plan Policy G5 Urban

Greening (Greater London Authority, 2021). Examples of how an urban greening scheme could demonstrate it is locally appropriate include, but are not limited to:

• Providing green routes that promote active travel where current opportunities are limited
• Designing a SuDS scheme which reduces surface water run-off into local water courses where there are particular issues of surface water drainage or flooding
• Taking design cues from local habitat types or the Local Nature Recovery plan or Biodiversity Action Plan
• Designing publicly accessible open space to reduce local deficiencies in access to open space
• Providing other types of publicly accessible greening (such as pocket parks) where a reduction in deficiency to open space cannot be achieved. (Greater London Authority, 2021)

This method, which is being widely applied in London needs to be applied everywhere as it given a highly accurate rating of an establishment. It is of the utmost importance that we start focusing on damage control now. The “big” architectural establishments, some of which I have mentioned before, are of the utmost necessity but what is more important is the “small” contributions of each and every single one of us. It is only when every person does their part, the buildings can help in really making a dent in this uphill battle against climate change.

Conclusion

It is clear that, a green or sustainable building because of its construction and features can maintain or improve the quality of life of the environment in which it is located. To do this, it is essential to achieve a high level of efficiency by reducing the consumption of energy, water and other resources to minimize pollution. In the given examples, we can see that they are

constructed in a sustainable manner by proper landscaping and architectural efficiencies. Global climate change is one of the most urgent challenges facing humanity today and sustainable development is no longer an option; it is the only way forward. Those architectural designs mentioned in this paper, with its innovative urban planning and environmental advantages are the technological solutions which can be adopted in any urban landscapes for a sustainable future.

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