

An architectural approach towards a sustainable development

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Abstract

Sustainable development is an organising principle for human life on a planet. It can actually be defined as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. The broader topic "Sustainability" is believed to be supported on three pillars, the environmental sustainability, economic sustainability and social sustainability. The burning issues which are being confronted today are, Global warming of atmosphere and green-house gases accumulation, Ozone layer thinning away with all negative impacts, which are the result of going against the ecological laws. In order to answer to all these boiling issues, major steps have to be taken at the root level itself. The first step needs to be the identification as to, what is environmentally desirable and what are the most feasible options for achieving them be it physical, economic, social and technological. Majorly the effort which has to be initiated with, is identification of processes, which deal with various activities for creation of the plans seeking to identify what is environmentally desirable. Wise use of activity and resources will have a positive effect on the environment. Without proactive environmental management, development is unlikely to be sustainable and people will be more vulnerable to disasters. Thus a sincere effort should be made to stretch what nature provides to the optimum and maintain that expansion indefinitely without environmental breakdown, in order to maximize human well-being, security and adaptability. Due to the rapid increase in construction activity many negative impacts are being observed. Buildings that are designed and used today contribute to serious environmental problems due to excessive consumption of energy and other natural resources. An integrated approach towards the building design should be adopted which will result in energy resource efficiency. Present Research paper will include the process, steps and techniques a designer in the present day should incorporate in his design, right from the site selection to the finishing stage so as to safeguard the future of human beings thus accomplish the goal of sustainability.

Keywords: Sustainable, energy efficiency, passive techniques, green building

INTRODUCTION

Phenomena like increasing Population, Migration, Urbanization and Industrialization has given a boost to construction industry. Many buildings viz. houses, apartments, commercial complex, skyscrapers etc. are being designed. However it is observed that in many cases the environmental aspects are being ignored leading to uncomfortable habitat. It can be read that, with the construction activity going on vigorously, the so called Built environment, is having notable impacts on the overall environment, human health and economy as well. The hazardous effect can be observed in the form of Global warming, Green house effect, ozone layer depletion and so on. The health or it can be said that the actual Future of the human beings is at stake. Thus to address to these climatic changes and the related issues, the only wise move can be to adopt a sustainable development pathway, by shifting to an environmentally sustainable construction. The actual core of Architecture lie in the connection between the natural place and its inherent ability to provide comfort and security to the inhabitants. A

look back at the traditional building techniques, shows clearly, that the concept of sustainable buildings has existed in our country since past. Architecture 100 yrs ago provided comfort just by integrating the passive elements of natural place in the design. These elements were the very foundation of the architectural profession grounded in sustainable principals before they were called such. Thus a place-based design should actually be the main objective of a sustainable construction, which talks about integrating the natural characteristics and resources into the site.

Achieving Sustainability in Building

Sustainable construction starts with planning and design. The approach towards sustainability starts at the stage of site selection itself. The following points should be clearly dealt with at the stage of site selection and development.

The Site: Challenges and Opportunities

A comprehensive and intense analysis of the site is the first and foremost task to be carried out. This will actually help in dictating the design of that particular place, for achieving sustainability. The analysis of site along with ecology, geologic history and the climate will help in determining the issues such as:

- Orientation of the building

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- Form and size of the building
- Location of the openings as per the climate
- Low maintenance strategy for the operational cost of the building

The soil, natural slope of the site should never be ignored, as these give the natural form and character to the site. Going against these natural pattern will then require mechanical intervention which will go against the term "sustainable". To create an architecture that is sustainable should be site specific. It is important to study the site in the following context:

(a) Study of site in relation to the region- First the regional climate should be studied and then its relationship with the site climate should be studied. One should know as to how that climate corresponds to the human comfort. The urban and natural characteristics of the region should also be determined as this will help in integrating the site design to the natural and historic value of the place.

(b) Study of site in relation to the neighbouring sites- The relationship of the site to the neighbouring sites should be studied in the context of scale, view, materials, neighbourhood character and proportions. The indigenous vegetation types be determined and their potential uses for cooling, shading, storm protection, water retention should be known. Their impact on temperature, air movement and humidity on the site also need to be determined as they will play a major role to produce a sustainable design. The impact of adjacent land uses and the site resulting microclimate should be studied thoroughly.

(c) Study of building in relation to the site-This step will include determining the basic layout of the building keeping into mind the human need and the site climate by making use of the wind direction, natural slope etc. Basically it will include placements of the rooms or requirements as per the studies made above by maximum utilization of the natural factors. The entire planning should be done in such a way that the design adopts the natural environment with minimum of maintenance and life cycle cost. The above step wise procedure will lead to

- Increase the efficient use of site and optimum use of its resources
- Eliminate the use of non renewable resources
- Design the building envelope appropriate to the climate
- Improving the air quality
- Reducing the maintenance cost

This in-depth analysis of the site when integrated with the design will finally result into a self sustainable design without unnecessary mechanical and environmental costs.

Energy Efficiency in Buildings

Buildings that are designed and used today contribute to serious environmental problems due to excessive consumption of energy and other natural resources. The close connection between energy use in building and environmental damage arises due to the

energy intensive solution used in the construction of the building and meet its demand of heating, cooling, ventilation and lighting which in result, is causing in depletion of invaluable environmental resources. An architect should make an effort to design such a building which meets the occupant's need for thermal comfort, at reduced levels of energy and resource consumption. An integrated approach towards the building design should be adopted which will result in energy resource efficiency. The steps can be listed as:

- Incorporating Solar passive techniques in building design to minimize the load on conventional system (heating, cooling, ventilation and lighting)
- Design energy-efficient lighting and HVAC systems
- Using renewable energy systems viz. Solar photovoltaic systems / solar water heating systems to meet a part of building load.
- Use of low energy materials and methods of construction and also making an effort to reduce the transportation energy.

In short it can be said that an energy efficient building design will balance all the aspects of energy use in the building.

Architects can achieve energy efficiency in the building by studying the micro and macro climate of the site, applying the bioclimatic architectural principals to combat the adverse conditions and taking advantage of desirable conditions like :

a) **Landscaping**-Landscaping play an important role in altering the microclimate of a place. If properly done it will reduce direct sun from heating up the surface of the building. As it is well known that trees are the primary elements of an energy conserving landscape. They help in regulating the air flow, thus directing or diverting the wing flow advantageously. The shade created by the trees help in reducing the temperature in the adjoining building and providing evaporative cooling.

b) **Building form**- Always it is believed that a compact shape the less wasteful it is in gaining or loosing heat. The building form and the depth of the building also play an important role as it determines the air flow around the building thus affecting ventilation. Another aspect to be kept in mind while planning is to keep the depth of the building minimum as because the need for artificial lighting will increase with the depth of the building.

c) **Water bodies** – Water bodies act as a modifier of the microclimate of a place. It helps in evaporative cooling especially in Hot- Dry climates whereas it should be avoided in humid climates as it adds to humidity.

d) **Orientation** – Orientation of the building is next major design consideration with respect to solar radiation and wind. A careful design can help in shading. Special devices can be incorporated to exclude or redirect sun and wind in the building to a desired extent.

e) **Fenestration and Building Envelope** – The openings should be properly located and designed as this will help in keeping the sun and wind out from the building or allowed in the building as per the climatic requirement.

The Building envelope plays an important role in the design of any buildings as, its components are the key determinants of the

amount of heat gain or loss and wind flow inside the building. The primary elements affecting the performance of the building are

- Materials and construction techniques- choice of materials help in maximizing the thermal comfort
- Roof- Receives maximum solar radiation and can be used advantageously for effective daylighting and ventilation by incorporating vents and skylights in the design.
- Walls- These also receive a large amount of radiation. In hot regions appropriate thermal insulation and air cavities in walls can reduce heat transmission inside the building.
- Finishes- The external finish of the surface determines the amount of heat absorbed or discarded by it. Thus for example if a lighter colour surface be used for warm climates then such surfaces will have higher emissivity.

The skin of the building should be such that it should breathe, and be functionally efficient as per the climate of the region or place.

Green Roofs

Green roofs are lightweight, engineered roofing systems that protect the integrity of the roof and provide many benefits for stormwater management and energy efficiency.

Benefits of Green Roofs:

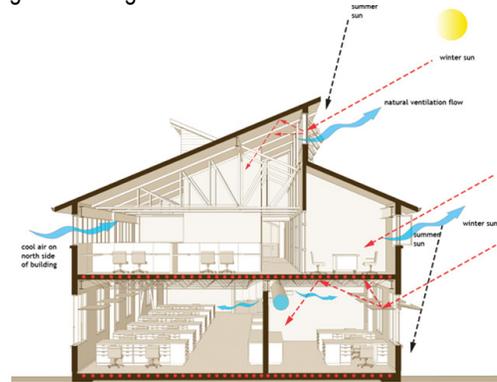
- Reduced heating due to fewer fluctuations in roof temperature and insulating properties of vegetation
- Reduced cooling costs due to fewer fluctuations in roof temperature and heat loss due to evaporation in the summer
- Increased property value
- Extension of the life of the roof membrane because of protection from intense ultraviolet radiation and continued expansion and contraction due to fluctuating temperatures
- Noise insulation



Passive Cooling Techniques

In early centuries the designs were done taking advantage of temperature variations, convection breeze, evaporative cooling, shading etc. which were totally forgotten in modern days constructions. Thus today with an increasing environmental costs and growing environmental concerns many of these techniques once again are gaining importance. The applicability of these systems depends entirely on the existing climatic conditions.

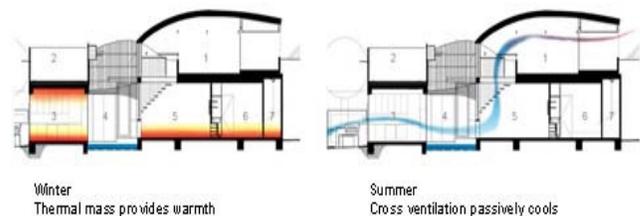
a) Natural ventilation- Good ventilation requires location of openings in opposite pressure zones. Architects use stack effect technique in the building, so as to allow warm air to escape the building from the top and allowing the cooler air into the building from the openings near the ground.



b) Wind tower- In this, the hot air enters the tower through the openings of the tower, gets cooled becomes heavier and then sinks down. Inlet and outlet of the room should be so designed so as to induce cool air movement. The tower walls absorb heat during daytime and release it during the night. This system works well for single units but not for the multi-storeyed buildings.



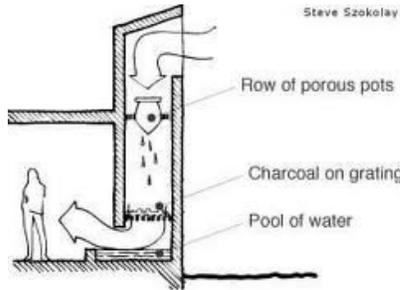
c) Courtyard Effect- Due to the incident solar radiation in the courtyards the air gets warmer and rises. Cool air then from the ground level flows through the louvered openings of rooms surrounding the courtyard thus resulting in air flow. This technique was very commonly practised in the olden days.



d) Earth Air Tunnels- At a depth of about 4m below the ground the temperature inside the earth remains nearly constant round the year and is equal to annual average temperature of the place. A tunnel in the shape of pipe is embedded at a depth of 4m and the ambient air

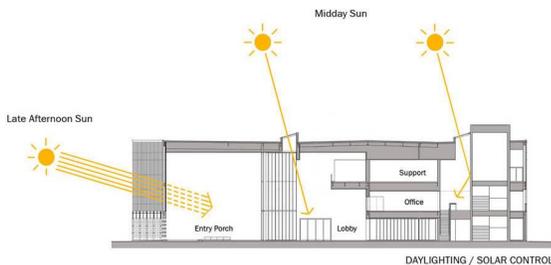
ventilated through this tunnel will get cooled in summer and warmed in winter and this air thus can be used for cooling in summer and heating in winter.

e) Evaporative cooling- This technique lowers the indoor air temperature. It is effective in Hot and Dry climate where temperature humidity is low. The air when passes over a water body placed near the building in the direction of wind flow, it gets cooled thus cooling the living space of the building in turn.



f) Passive Draught Cooling- Wind catchers are used here which guide the outside air over water-filled pots, inducing evaporation and causing a significant drop in the temperature before the air enters the interior. These wind catchers act as a primary element in architectural form also

g) Day lighting – Day lighting again has considerable Energy-efficient implications. It should be used properly used to avoid the dependence on the mechanical means.



Building infrastructure

Building sites contain many infrastructure eg. Storm water control, sewers water supply, heating, ventilation, lighting etc. Sustainable infrastructure design is not just about new infrastructure, it is about rehabilitation, reuse or optimisation of existing infrastructure, which is consistent with the principles of urban sustainability and global sustainable development. Renovating and Reusing the existing infrastructure is one of the most effective design approach.

Solutions for sustainable development

Various solutions have been suggested and many have been successfully implemented in various countries to produce clean energy and maintain sustainability. These solutions include building more nuclear plants, geothermal power and heat, solar heating and cooling, wind power, modern forms of bio-energy, solar photovoltaics .Development of alternative fuels have also been initiated such as bio-diesel, non fossil methane vegetation oil and

other bio-mass sources have also been implemented each one having their own advantages. One of the initiatives to counter the damage done and prevent the subsequent damage done to the environment gave rise to the concept of “Green Building”.

Green Building

This concept of Green Building is a new approach in the Architectural world, to save the natural resources such as water, energy and materials used in the construction operation and the maintenance of the buildings eliminating the bad effects of buildings on the environment and the population. Construction of Green Buildings over conventional, ones aims at earth and its habitats retaining nature to the original state to an extent in three ways by:

1. Retaining the external environment of the structures.
2. Preserving the environment away from the structures.
3. Improving internal environment for the persons using the structures

A Green sustainable building design is one that achieves high performance over the full life cycle, in the following areas:-

- Minimizing natural consumption through more efficient utilization of non-renewable natural resources, land, water and construction materials including the utilization of renewable energy resources to achieve net zero energy consumption.
- Minimizing emissions that negatively impact our indoor environment and the atmosphere of our planet, especially those related to indoor air quality, green house gases, global warming, acid rains.
- Minimizing discharge of solid waste and liquid effluents, including demolition and occupant waste, sewer and storm water and the associated infrastructure required to accommodate removal.
- Minimum negative impact on the site ecosystems.
- Maximal quality of indoor environment, including air quality, thermal regime illumination, acoustics/noise and visual aspects to provide comfortable human psychological and physiological perceptions.
- Worldwide Green buildings are certified through an independent body, the US Green Building Council (USGBC) through LEED (Leadership in Energy and Environmental Design) Certification Program.

Thus to sum up the following should be the design considerations made by the architects towards a sustainable building design:

- a) Using the resources at the speed at which they naturally regenerate and discarded only at the speed at which local ecosystems can absorb them
- b) Incorporate resources naturally available on the site while site planning, such as solar and wind energy, natural shading and drainage
- c) Using resource-efficient materials
- d) Minimizing Energy and material waste throughout the building's life-cycle, through reuse or demolition

- e) Designing the building skin for energy efficiency considering factors such as day lighting, passive ventilation, building envelop, internal load, local climate etc
- f) Using materials and the design strategies such that they result in excellent indoor environmental quality.
- g) Operation and maintenance system designed supporting waste reduction and recycling.
- h) Treating water as a limited resource
- i) The main focus of the design should be on occupants' health and productivity

CONCLUSION

India is a fast developing country, witnessing tremendous growth in all the sectors. Climate change is the most urgent sustainable development challenge today as the environment impacts of Global warming threatens to undo many of the development efforts being made. Targeted and efficiently planned environmental sustainability issues can have strong positive impact. Also the existing communities, towns and regions are a great challenge to sustainability. It is clear that sustainable approach is totally based on natural systems. The art of architectural planning always should have its objective of, combining the aesthetic and the functional. The considerable energy that is present in nature is enough to provide a sustainable future if used properly. So the designers should try to convince policy makers as well as stake holders so as to reduce carbon emission though indirectly in long term. Use of the Energy – efficient strategies are the primary strengths of the buildings. In the present era of growing environmental concerns, it is very important for the designer to take useful measures while doing a design thus creating a better

tomorrow.

REFERENCES

- [1]<http://www.openclinical.org/dss.html>
- [2]W. Steen *et al.*, 2004. Global Change and the Earth System: A Planet Under Pressure Stockholm: IGBP Secretariat Royal Swedish Academy of Sciences, 5.
- [3]Sustainability has much in common with “quality of life,” including discussions over universal and relative bases for assessment. For an important discussion of this tension, see Martha Nussbaum, “Non-Relative Virtues: An Aristotelian Approach,” in *The Quality of Life*, 242–69.
- [4]Doyle, “Sustainable Development,” 774
- [5]Gilbert,N. 2009. Efforts to sustain biodiversity fall short. *Nature* 462,263.
- [6]Walpole,M *et al.*2009.Tracking progress towards the 2010 biodiversity target and beyond. *Science* 325,1503-4.
- [7]Anderson, D. 1995. Energy efficiency and the economists. *Annu. Rev. Energy Environ.* 20:495-511.
- [8]Sustainable Building Sourcebook. 1994. City of Austin's Green Building Program. Retrieved Dec. 03, 2004, from <http://www.greenbuilder.com/sourcebook/>.
- [9]Zaslow, S., and Cox, B. *Passive Solar Retrofit for North Carolina*.Raleigh, NC: North Carolina Solar Center, 1999.
- [10] Cassedy, E.S. 2000. *Prospect for Sustainable Energy: A Critical Assessment*. Cambridge:Cambridge Univ. Press.