The Essential Considerations for Sustainable Design Development

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Abstract:

This paper presents the essential considerations for the sustainable design development in Indian Landscape. The concept of sustainability interpret in numerous ways like, green building, energy efficient buildings, low carbon emission building, bioclimatic architecture etc. are some of the terms used to represent the of sustainable design development. And the Indian landscape varies in terms of Geography, Climate, and Culture etc. so it is quite difficult to propose uniform set rules for the sustainable design development. In this paper author tries to identify the essential consideration for sustainable design development in Indian Landscape.

Keywords: *sustainable design strategies, sustainable design development, climate responsive architecture, and environmental ethics*

INTRODUCTION

Sustainable buildings are not a new style of buildings. It's a way to think that how we design, construct, and operate buildings with less effect on environment. Its primary goal is to reduce the negative potential of buildings that harms nature. And the ultimate goal is to make possible that our building (offices, homes) to become producers of energy, food, clean water and air for the humans and other biological communities.

"The modern architect has produced the most flagrantly uneconomic and uncomfortable buildings…which can be inhabited only with the aid of the most expensive devices of heating and refrigeration. The irrationality of this system of construction is visible today in every city from New York to San Francisco: glass sheathed buildings without any contact with fresh air, sunlight, or view." -Lewis Mumford.

And now a day's the way architecture is transformed it is very difficult to think about the interaction of built environment and nature. The current environmental problems of the world are the result of this kind of paradigm and the designers need to rethink on their Radical thinking.

It is an **Architect** that has control over the design of buildings must take charge of ensuring that they are better designed in order to reduce their negative impact on the environment.

It is predicted that Building industry is responsible for 40% to 70% of the world's carbon emissions. Therefore, to deal with this crisis, we need to rethink on our design strategies. So that, it must change in the way that building industry minimize their dependency on fossil fuels for energy which causes GHG.

THE KYOTO PROTOCOL:

The purpose of the Kyoto Protocol was to stabilize atmospheric concentrations of greenhouse gases at today's levels will require reducing human-generated emissions by 80 percent immediately. There are six greenhouse gases covered under the protocol to the international convention on climate change (the Kyoto Protocol);

- Carbon dioxide (CO2),
- Methane,
- Nitrous oxide,
- Hydro fluorocarbons (HFCs),
- Perfluorocarbons (PFCs) and
- Sulphur hexafluoride (SF6).

The Kyoto protocol was agreed upon through international co-operation under the United Nations Framework Convention on Climate Change (UNFCCC), which was created in 1992.

The Kyoto protocol came out of the UNFCCC's December 1997 meeting held in Kyoto, Japan.

Under the agreement, industrialized nations must reduce their emissions of greenhouse gases by an average of 5.2 per cent (from 1990 levels) by the period 2008 to 2012.

CHALLENGES FOR SUSTAINABLE DESIGN DEVELOPMENT:

Architects need to figure out how to solve this problem by designing buildings more sustainably and holistically. Also we need to figure out how to use less fossil based fuels as eventually we simply won't be able to rely on them.

So the solution to this is to create an Environmental Architecture because Environmental or Sustainable Architecture can make a huge difference.

The Design and Construction Industry might be considered as the potential single largest contributor (40%) to solutions for compliance with the Kyoto Protocol and for creating long term ecological sustainability.

Environmental Design is definitely an avenue towards sustainability. And there is great potential for 'Environmental Leadership' in the architectural profession. No one else in the building industry is so educated to be able to incorporate ALL aspects of technology, environment, culture and design into our built environments.

Architect Thomas Fischer, a notable educator in the United States (currently Dean of the Architecture Department of the University of Minnesota) defined five principles of an Environmental Architecture:

The building should have a:

- Healthful Interior Environment.
- Demonstrate Energy Efficiency.
- Use Ecologically Benign Materials.
- Have an Environmental Form.
- Good Design.

Healthful Interior Environment: All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere. Additional measures are to be taken to clean and revitalize interior air with filtration and plantings.

Energy Efficient: All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating and lighting systems are to use methods and products that conserve or eliminate energy use.

Ecologically Benign Materials: To use Ecologically Benign Materials that minimizes destruction of the global environment. Wooden Materials if used, is to be selected based on non-destructive forestry practices. Other materials and products are to be considered based on the toxic waste output of production.

Environmental Form: All possible measures are to be taken to relate the form and plan of the design to the site, the region and the climate. Measures are to be taken to "heal" and augment the ecology of the site. Accommodations are to be made for recycling and energy efficiency. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitants and nature.

Good Design: For a building to have Good Design all possible measures are to be taken to achieve an efficient, long lasting and elegant relationship of use areas, circulation, building form, mechanical systems and construction technology. Symbolic relationships with appropriate history, the Earth and spiritual principles are to be searched for and expressed. Finished buildings shall be well built, easy to use and beautiful.

BUILDINGS AND CLIMATE RESPONSE:

Climate varies around the globe and indigenous architecture used to respond to local climate through the use of natural heating and cooling methods that were not reliant on mechanical systems, as well as natural and local materials. 20th century buildings became exclusively dependent on mechanical systems for heating and cooling of buildings and systemically ignored climate issues.

International Architecture style, that ignored climate and very much succeeded if one examines the many sealed glass office towers that populate cities from Houston, to Toronto to Chicago or New York. The architecture is almost precisely the same, regardless of the temperature and relative humidity of the climate.

This resulted in a proliferation of architecture that does not properly respond to its climate and that is also using excessive amounts of fossil fuels to heat and cool the interiors of the buildings. Even then, some of these buildings fail to create inspirational, or even comfortable, interior environments.

Major Climatic zones in India: India has a large variation in climate from region to region, due to its vast size and variation in geography. India experiences climate from four major climate groups. These can be further subdivided into seven climatic types.

Weather and Climate:

The weather of the world varies by location as relates to the distance from the equator and as influenced by aspects of geography such as the trade winds, adjacency to bodies of water, elevation, etc. The earth's atmosphere helps to moderate the climate to prevent radical shifts in temperature from season to season and day to night. If we understand our local weather patterns, we can learn to use these natural factors to more sustainably design our buildings.

The Sun: The impact of the sun on our buildings is a direct result of our distance from the equator. This affects amounts of solar radiation as well as solar geometry.

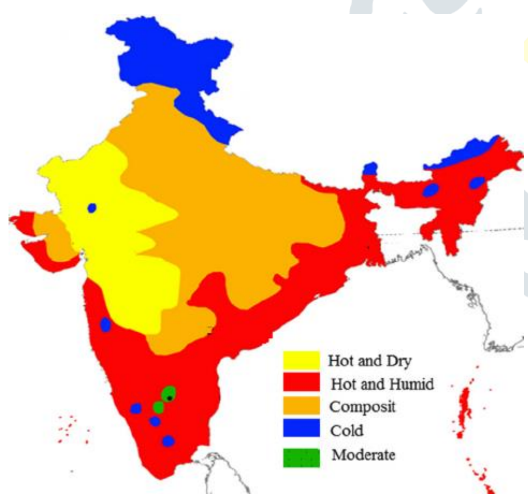
Solar geometry changes as a function of both the time of day as well as time of year. This alters the amount of solar radiation (free heat) that can be used to heat our buildings.

Solar geometries, solar radiation intensity, the length of daylight hours and seasonal variations are different around the world. These characteristics must very specifically be incorporated into sustainable, climate responsive, building design. Weather might be variable, but solar geometry is very precise and predictable.

Building as an Environmental Moderator: The severity and type of the local climate will impact the design of the building envelope. These variations can either be the function of the building envelope as an environmental moderator easier, or more challenging.

High Performance Buildings: There is a growing trend towards the construction of High Performance Buildings as a sustainable design solution that is both climates responsive and accountable. These buildings also have "thin skins".

Bio-climatic Design: The idea of bio-climatic design lies in the need for the architecture to be modified to respond to the regional climate type. Design must first acknowledge regional, local and microclimate impacts on the building and site.



Different climates around the world: The vernacular architecture associated with each climate type, we can begin to understand the range of available natural solutions to the problems to be solved in sustainable building. It is critically important when looking for inspiration in architectural design, that inspiration be drawn from projects whose climate is highly similar to the one in which you are designing. These different climates are enough to require very different envelope design practices and regulations. This mostly concerns insulation and water penetration, as well as humidity concerns.

Traditional cold climate design: Traditional cold climate design took to task the shedding of snow from roofs and used minimal windows in the walls to try to keep heat inside the building especially in Northern part of India. Most of these buildings were constructed of solid masonry and devoid of insulation. Modern insulation types had not even been invented. But this time heating costs were very low, nobody was concerned about CO2 emissions and global warming, so fossil fuels were burned as required to keep buildings reasonably warm. Comfort expectations were also not extremely high, so occupants were content to don a sweater and slippers if the house was draughty or cool, and in the summer, open the windows and slow down their pace, if the interiors were too hot.

***Comfort Zone*:** The Comfort Zone refers to the range of temperature conditions of air movement, humidity and exposure to direct sunlight, under which a moderately clothed human feels "comfortable". This will be different for Indoor versus Outdoor conditions and these will be different for different climate types. There is a range of comfort that we need to achieve through design.

Passive Bio-climatic Design: The Comfort expectations may be reassessed in light of growing concerns about energy and Global Warming that is the result of burning excessive amounts of fossil fuels to allow for the wider "zone" that is characteristic of buildings that are not exclusively controlled via mechanical systems. This may entail the creation of new **"buffer spaces"** to make a hierarchy of comfort levels within buildings.

This will require higher occupant involvement to adjust the building to modify the temperature and air flow. People will need to open and shut windows and blinds. Winter and summer clothing will need to be different. The indoor temperatures and relative humidity will not be consistent throughout the year.

Microclimate: When we design with the specific local environmental characteristics in mind, we start to manipulate the relationship between the climate, the site and the building to create a local environment or microclimate around the building. This "mini climate" that is created around the building can decrease the apparent severity of the climate (and hence the work the building must do to make for a comfortable interior and exterior environment around the building) or, if badly handled, can increase the severity of the local climate.

The Multivariate Condition: The base variables include the People, the Building, the Site and the Climate. Architecture can be used to mediate the building and the site, as a function of the way the materials are chosen and the configurations are set. People will also impact the success of the comfort of the interior conditions. Different buildings are used for different functions and thereby the activities and numbers of the occupants will vary. These will impact the design target for the comfort conditions. Houses can take a wider comfort range than can an office or school as too much heat, humidity or chill can negatively impact the performance of the inhabitants. The Local climate has an enormous impact on the overall design of the building if energy requirements are to be effectively minimized.

Urban Heat Island Effect: Access to green space can keep the building cool. The "urban heat island effect" is caused by too much building, hot roofs, pavement, *(aka thermal mass)* and not enough greenery in cities. Tree cover is also important to keep the sun off of paved areas. The microclimate in urban centers can be very different from more natural sites.

Bio-climatic Design (cold):

A cold climate is deemed to exist where winter is the dominant season and concerns for conserving heat predominates all other concerns. Heating degree days greatly exceed cooling degree days. The general rules that govern Cold Climate Design are:

First insulate – the insulation place in the envelope (walls, roof and floor) acts to retard the flow of heat from the interior to the exterior in the winter (remembering that heat flows from HOT to COLD, and the flow rate is accelerated when the temperature differential across the envelope is higher)

Exceed CODE requirements: current building code requirements are considered to be minimal if you are trying to design sustainably and achieve maximum energy efficiency. Studies have been done that would indicate that to be more energy efficient, doubling of the current recommendation is in order. This will make envelope detailing more challenging.

Minimize infiltration: Infiltration is the leakage of warm air out of minute cracks in the building envelope. As we are paying to heat that air, we don't want it to leak. Therefore we need to both detail and build our envelopes to be tight to reduce air changes.

Then insolate – insolation is the heating of the building interior, naturally, by the sun. This will be explained in more detail under Passive Heating Design in the next PowerPoint. Suffice to say that if you let the sun shine into your building, and transfer its free energy into materials of thermal mass (concrete, brick, heavy clay tiles) that the building will gain free heating energy. This is called Direct Gain.

Building Orientation: If the building cannot receive free heat from the sun due to the orientation of its glazing away from the sun, then this will be a problem. Maximize south facing windows for easier control. When we look at solar angles in the Passive Design power point, you will see that south facing windows are preferable, both for the amount of free energy that they can provide, as well as the ease of shading them in the summer months when we wish to exclude unwanted heat from our building interiors. East and West facing windows are more difficult to control for solar issues. North facing windows do not benefit from solar gain, and result mostly in heating losses through the envelope.

Application of Thermal Mass: Thermal mass inside the building envelope to store the free solar heat. Materials like concrete, brick, and clay tiles are able to store heat and will reradiate it back into the building interior when the temperature drops enough to induce heat flow. (Temperature flows naturally from hot to cold).

Create a sheltered **microclimate** to make it less cold. If you design the site to capture the sun and buffer it from winter winds, it will make the local temperatures and conditions easier for the building to respond to.

Bio-climatic Design (HOT-ARID):

Hot arid conditions are deemed to exist where very high summer temperatures with great fluctuation predominate with dry conditions throughout the year. Cooling degrees days greatly exceed heating degree days. The general rules that govern Hot Arid design are:

Solar avoidance: keep direct solar gain out of the building. During the daylight hours completely avoid letting direct sun enter the building. This will mean keeping the window openings very small, or shading the openings, or providing ventilating shutters to allow air but not sun to enter the building. If the sun enters the building it will heat up the thermal mass of the building. This is the number one issue to avoid.

Avoid daytime ventilation: The daytime air in hot climates is HOT. You do not want to encourage it to enter the building. You only ventilate these buildings at night.

Promote night time flushing with cool evening air: The evening air in a desert climate is substantially cooler than in the daytime. If you promote ventilation in the cool evening hours you will draw heat out of the thermal mass of the building and cool it down for sleeping.

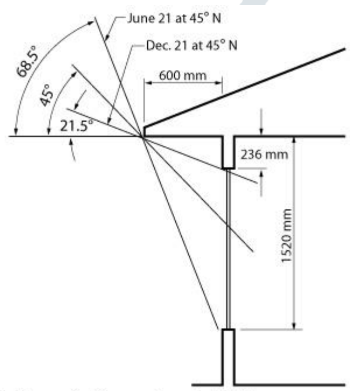
Daylight: Achieve day lighting by reflectance and use of LIGHT non-heat absorbing colors. If you use light colors the building will not attract or hold as much solar heat as dark colors absorb heat. Light colors will also help light to bounce around and achieve a good level of brightness without the use of direct beam radiation from the sun.

Establishing microclimate: Create a cooler MICROCLIMATE by using light / lightweight materials. Lightweight materials such as fabrics, rattan and wood do not hold heat. So use these materials for furnishings to keep the environment next to the body airy and cool. Respect the DIURNAL CYCLE Use heavy mass for walls and DO NOT INSULATE

Bio-climatic Design (hot humid):

A hot humid climate exists where warm to hot stable conditions predominate with high humidity throughout the year. Cooling degrees days greatly exceed heating degree days. The general rules that govern hot humid design are:

Solar avoidance: Design buildings with large roofs with overhangs that shade the walls and allow windows to be open at all times. These climates can also be very rainy and it is important for natural ventilation to allow the windows to be open during rainy times. Large roof overhangs can protect the openings and interior spaced from rain penetration.



Shading angles for a south wall at 45°N

Promote ventilation: In this type of climate is does not usually cool down at night so we do not need to prevent this air from entering the room. Often the only comfort possible is through the sensation on our skin of air movement. You can supplement the natural movement of air by fans. Ceiling and window or oscillating fans are good. Remember though that the fan is not cooling the space at all. It is merely giving the occupant the sensation of cooling. Ceiling fans can help to mix the air and prevent stratification.

Use of lightweight materials: that do not hold heat and that will not promote condensation and dampness (mold/mildew). Concrete and other such materials are not suitable here.

Eliminate basements and concrete: Basements in these types of climates have a huge tendency to hold dampness and promote the growth of mold. Use an alternate method of space creation for mechanical systems and storage. You won't want to use the moldy goods anyway! These types of climates tend not to have frost depth issues, so constructing a basement is not a natural byproduct of deep foundation walls.

Use stack effect: to ventilate through high spaces. Hot air rises. You can allow the natural rise of hot air plus high level operable windows to encourage the exhaust of the overheated interior air, thereby drawing in cooler outside air to replace it.

Use of courtyards: and semi-enclosed outside spaces. These are often cooler than the interior environments.

Use water features: for cooling. Even though the air is humid, water features can make the occupant feel cooler, even by the sound of the running water or fountain.

Bio-climatic Design (Temperate):

This climate is said to exist where the summers are hot and humid, and the winters are cool to cold. In much of the region the topography is generally flat, allowing cold winter winds to come in form the northwest and cool summer breezes to flow in from the southwest. The heating and cooling degree days are usually balanced. The four seasons are almost equally long.

The general rules that govern temperate design are:

Buildings will likely be designed with large openings to allow natural heating by the sun during the cold months, but include shading devices to protect the same openings from the sun during hot months. Openings will also provide for natural flow through ventilation for hot weather. A well-insulated envelope will assist in energy performance. For this climate it is important to maximize flexibility in order to be able to modify the envelope for varying climatic conditions. It will be very important to understand the natural benefits of solar angles that shade during the warm months and allow for heating during the cool months.

THE PASSIVE DESIGN STRATEGIES:

The Passive design is based upon the following climate considerations. It's an attempt to control thermal comfort (heating and cooling) without consuming fuels;

- Proper orientation of the building to control heat gain and heat loss,
- The shape of the building (plan, section) to control air flow,
- By using materials having less heat absorption value.
- Proper utilization of free solar energy for heating and lighting,
- Maximizing the use of free ventilation for cooling and to control heat gain.

It's an attempt to reduce the dependency on fuel for heating, cooling, lighting purpose and also to reduce the need for electricity to support lighting by using practices of day lighting.

In LEED, Passive Design assists in gaining points in the Energy and Atmosphere category, as well as in Indoor Air Quality as Passive Design promotes natural ventilation and day lighting strategies.

Passive Solar Heating Strategies:

There are three main strategies used in building design to admit and store the free heat from the sun and they are as follows;

- Direct Gain
- Thermal Storage Wall
- Sun space

The dominant architectural choice is Direct Gain as it clearly uses the windows to admit the sun and the materials inside the building to store the heat.

In a Thermal Storage wall, the thermal mass is placed between the windows and the interior space to absorb the heat. This precludes the use of the windows as vision glazing.

In a sun space the space between the glass and thermal storage wall is enlarged to permit seasonal use of the space.

Passive Cooling:

As much as possible, passive cooling uses natural forces, energies, and heat sinks. Since the goal is to create thermal comfort during the summer:

- ***Primary Passive Cooling Strategies:*** *Passive cooling relies on two primary strategies:*
- First and foremost, prevent heat from getting into the building. So that shading devices, enables a cool microclimate to discourage heat gain. (This can be done by planting trees, shrubs and vines around the building).
- ***Preventing Overheating in the Cooling Season:*** There are generally two main methods of preventing overheating:
- **Prevent the sun from hitting the glass**: This is done using roof overhangs, special shading devices or vegetation.
- **Use special glazing --** “Spectrally selective” glass filters the harmful rays out of the sunlight striking the glass.

CONCLUSION:

Building industry consumes lots of energy and resources that can be utilized in smart manner by adopting the sustainable ways of development. The sustainability parameters may vary from place to place but the basic concept and consideration remains the same. Architects and researchers argued on several events to transform the basic ideologies of design development. Generally in the era ‘form follows function’ or ‘function follows form’ is not sufficient if we are looking for sustainable development we need to incorporate of provided importance to the climate at designing level so that climate and concepts of sustainability cab be easily incorporated in the design.

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