# Challenges of Developing Sustainable Architecture and Design Models in Indian Cities

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## Abstract:

The lecture explores the parameters that define sustainable building design in modern Indian urban context and the major challenges in developing models, policies and evaluation techniques for green building design for Indian cities.

## Introduction:

Indian architecture with a heritage dating back to 2600 B.C. Mohenjadaro and Harrapan civilizations is confronted today with a 'green' agenda. Green buildings, Environmental Architecture and Eco-housing – are different names of the trend towards efficiency and conservation that emerged in the last decade, challenging building codes, materials and even designs used in modern urban architecture.

Whether we like it or not, Green has become a fad. Whether it is deeply comprehended or superficially adopted, green is here and taking shape. The boundaries of Green remain yet undefined, open to interpretation to its many stakeholders.

The Indian Green Building Council, the nodal agency providing LEED (Leadership in Energy and Environment Design) certification, has registered a footprint of nearly 298 million square feet while the new national green rating system of India, GRIHA (Green Rating for Integrated Habitat Assessment) has nearly 202 million square feet registered to its credit, bringing the total tally of green buildings to nearly 500 million square feet in India. This is a remarkable achievement in a brief span of time. However, there is a need to view this development in a larger and more specific local context. There are a large number of modern buildings which have substantially improved environmental performance but are not certified.

Critics of the modern rating systems for green buildings state that the country's vernacular architecture is more than Green. Built to context they present local solutions to global issues. From the *Chettinad* houses of South India to *Wadas* of Western India, *Bungas* and *Havelis* of Rajasthan, present an array of structures whose design has evolved over millennia, which are bio-climatically responsive and culturally sensitive. Many point out that modern rating

systems such as LEED presuppose a conditioned building which by itself is a huge energy guzzler and emitter of greenhouse gas emissions.

Further, LEED is market-driven mechanism – in that a green certified building may satisfy the basic criteria in the rating system and yet not be energy or water efficient. Beyond these, lie some intrinsic questions: How much of our footprint, green or otherwise, can the earth's bio-capacity provide for?

One can trace this question back to 1972 when the Club of Rome commissioned a group of scientists and economists to study the complex inter-relationship between five major trends of global concern at the time – accelerating industrialization, rapid population growth, depleting non-renewable resources, widespread malnutrition and deteriorating environment. The Report of the group comprising Donella and Dennis Meadows, Jorgen Randers and William W. Behrens III was called 'The Limits to Growth'. It provided two models of the world – one in which growth of the 5 elements continues at the same pace such that the planet will reach its limits to growth sometime within the next 100 years - resulting in uncontrollable decline in both population and industrial capacity. The second model suggested a state of equilibrium between the two opposing forces of population and capital growth leading to economic and ecologic stability, where the material needs of all are satisfied providing equal opportunities to every individual to realize their human potential.

So, while we toil to 'reduce heat gain' and 'maintain ventilation rates' as per the norms of a rating system, we must bear in mind that what is at stake is the earth itself and the human race. Let us grasp the foundations of sustainability, so lucidly defined by David Gottfried, the founder of the USGBC (United States Green Building Council) in his book, Greed to Green: "Sustainability is about the two most complex systems on earth – human and living systems. The interrelationship between these two systems marks every person's existence and underlines the rise and fall of every civilization. Historically, no civilization has reversed its tracks with respect to the environment but rather has declined and disappeared because it forfeited its own habitat. For the first time in history, a civilization – its people, companies and governments – are trying to arrest this slide and understand how to live on earth. This is watershed in human existence."

## Background:

**Evolution of the modern green building movement:**
The green building movement in India started in the late 1990s influenced by a world-wide concern for reducing energy, water, material and other natural sources. The architectural community in India, at this time, was largely working within the purview of local bye-laws and designs influenced by the Western world. Exceptions were provided by designers who were trained abroad in energy or environmental design or those whose learning had been influenced by deep-rooted local and cultural context.

**Environmental Architecture in the Curriculum:** In 1998, Rachana Sansad's Academy of Architecture organized an international conference on Sustainable Architecture and Design in collaboration with the International Institute for Sustainable Future, Mumbai. This led to the first academic postgraduate program in Environmental Architecture in 2002. Although postgraduate programs in environmental planning existed in colleges of architecture, environmental architecture made its debut here. Today the postgraduate program includes a two-year Masters Degree program in Environmental Architecture. Several other colleges have started similar courses as there is an increasing demand for environmental architects.

**Environmental Architecture in Business & Practice:** On the practical front, one of India's largest business houses, Godrej, set up the CII-Sohrabji Godrej Green Business Centre (GBC) as a Centre of Excellence of the Confederation of Indian Industry (CII) for Energy Efficiency, Green Buildings, Renewable Energy, Water, Environment and Recycling and Climate Change activities in India. An initiative of the Federal Government of the state of Andhra Pradesh, Indian Industry and House of Godrej with technical support of USAID, it was set up in March 2000 during the visit of the US President, Mr Bill Clinton to India.

The building housing the CII GBC designed by Baroda-based Architect Karan Grover, became the first LEED certified building in India gaining 56 out of 69 possible points. This was the first Platinum-rated building outside of the USA and the third in the world. In 2004, the Centre became the nodal agency for the Indian Green Building Council (IGBC), part of the World Green Building Council (WGBC) 'actively involved in promoting the green building concept in India' and with 'a vision to usher in a green building revolution and facilitate in India emerging as one of the world leaders in green buildings by 2010'.

**Leadership in Energy and Environment Design (LEED):** The Indian Green Building Council (IGBC) uses the LEED (Leadership in Energy & Environment Design) rating system developed by the US Green Building Council (USGBC) founded in 1993 by a Stanford Graduate and real-estate developer, David Gottfried, who having reached the pinnacle of his remarkably successful career in real estate, went on to pen the first guidelines for buildings which have now begun to be termed GREEN. The USGBC set up measures for ecological site planning, energy efficiency and improved indoor air quality, water management and waste management in buildings that could be measured and rated. LEED India was a modified version adapted to Indian context by an expert committee set up by the CII GBC.

**Eco-Housing:** In 2005, the US Asia Environmental Partnership (USAEP) initiated Eco-housing guideline for residential buildings in India along the lines of the LEED model but adapted to Indian conditions. A team comprising Rachana Sansad's Institute of Environmental Architecture, The Energy Resources Institute (TERI), the Indian Institute of Architects (IIA), Builders Association of India (BAI) and several others, began work on an indigenous green building guideline with the International Institution of Energy Conservation (IIEC) & the University of Pune's Science and Technology Park as

implementing agencies. The 'Eco-housing' guideline which was developed as an outcome of this partnership for residential dwellings has been adopted by the Pune municipality. With incentives such as waiving off development and property charges for developers and better interest rates in home loans for customers, it is suitable for residential buildings for the composite climate of Pune. In August 2009, Eco-housing under the IIEC released its second version of guidelines for five climatic zones of India.

**Green Rating for Integrated Habitat Assessment (GRIHA):** Meanwhile, the government of India has adopted GRIHA (Green Rating for Integrated Habitat Assessment) as the national green building rating system. Conceived by The Energy Resources Institute (TERI) and developed by the Ministry of New and Renewable Energy Sources, Govt. of India, GRIHA meaning 'abode' in Sanskrit, was established in 2006 to rate new buildings for their environmental impact during three stages – pre-construction, building planning & construction and building maintenance stage. The Indian Govt. provides economic incentives for architects and developers as well as clients for efficient design and use of renewable energy sources through the rating system.

**The Energy Conservation Building Code (ECBC),** formally launched by the Bureau of Energy Efficiency (BEE), a part of the Ministry of Power, Government of India, in collaboration with the United States Agency for International Development (USAID), in May 2007, is policy measure to reduce the adverse impact of buildings on environment with specific reference to energy use to meet the goals of India's Eleventh Five Year Plan. Buildings that comply with this code feature reduced energy demand and efficient use of energy without compromising on crucial aspects like building function and human comfort; they in fact, contribute to better health and productivity of the occupants.

Buildings and the building industry can save significantly on energy costs through regulation of energy consumption levels in buildings. The ECBC provides prescriptive and performance-based mechanism to reduce energy use in buildings. Energy modelling and simulation which are primary tools for ECBC, provide advance feedback to architects on the implications of different design decisions on the energy performance of buildings along with maximum freedom for creative design and cost-effectiveness.

## Green Building rating systems:

Comprising of six topics – site planning, energy and atmosphere, water efficiency, indoor air quality, waste management and innovation in technology, the LEED rating system offers 69 points. Achieving a minimum of 26 points will provide a basic certification, 33 points a silver rating, 39 a gold rating and 52 a platinum rating. Most rating systems have a star rating or point system categorized under the major parameters of site, energy, water, waste, indoor air and innovation. Eco-housing and GRIHA provide flexibility to include passive design of buildings.

LEED differs from other systems in its flexibility and performance-based criteria. Starting from Commercial buildings, the rating system is now applicable for all types of buildings and projects such as institutional, core and shell, residential and interior as well as architectural projects.

The British Research Establishment's Environment Assessment Method or BREEAM is a predecessor practiced in Europe. Australia's Green Globe is another rating system gaining ground. Then, there are rating systems such as Energy Star which are limited to energy efficient equipments and devices, and Ecotel, which is limited to the hospitality industry.

The McGraw Hill Construction, a strategic partner of the USGBC published a report on the 'Global Green Building Trends' in 2008. The Report based on a survey of early market adopters and construction industry professionals in 45 countries had some interesting revelations:

- Nearly one-third or 32% of industry professionals perceive that green already makes up more than 10% of domestic construction output.
- Two-thirds (67%) of responding firms were currently dedicated to green on at least 16% of their projects
- Europe currently has the highest level of market activity, with 44% of responding firms building green on over 60% of projects.
- By 2013, 94% of responding firms will be building green on at least 16% of projects. More than half (53%) will be largely dedicated, building green on more than 60% of projects.
- The fastest green building market is in Asia, where the population of firms largely dedicated to green will nearly triple between 2008 and 2013 (from 26% to 73%).

## Defining green buildings or environmental architecture:

The Indian Green Building Council defines a green building as "one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

While Eco-housing defines it as housing that is "eco-friendly and energy efficient using sustainable construction practices, and a healthy and productive indoor environment with lowered use of natural resource. Eco-housing structures are designed, built, renovated and operated in an ecological and resource efficient manner."

GRIHA defines a green building as one that depletes as little of the natural resources during its construction and operation. The aim of a green building design is to:

• Minimize the demand on non-renewable resources and maximize the utilization efficiency of these resources when in use, and
• Maximize reuse and recycling of available resources
• Utilization of renewable resources.

We may conclude that in the modern urban Indian context, green buildings are considered to be those that use material and energy (fossil fuel) resources efficiently as well as provide a healthy and comfortable indoor environment and have least impact on the immediate surroundings.

## Green buildings and environmental sustainability:

In order for it to be more effective and sustainable, Green buildings must adopt the following:

**Green must focus on passive design:** As the green building movement is driven by rating systems, there is a need for emphasis on passive design of buildings. This means that buildings must be designed in the first place to be more suitable to macro and micro climate of the place and rely less on mechanical means of providing thermal comfort. Understanding the building in context of its surroundings and climate – average temperature, relative humidity, radiation, wind speed and direction, etc. is the first step for the designer. Modern simulation tools can aid in designing shading devices and façade details as well as help compute the heat gain or loss by the use of different materials. This is critical to reducing energy consumption and carbon emissions.

**Green must become intrinsic:** Green buildings must become part of building bye-laws in addition to the rating systems that currently exist in India and elsewhere. The Energy Conservation Building Code of the Government of India, when it becomes mandatory, will be a first step in this direction which should soon be followed by mandatory norms within municipal bye-laws of cities if large scale environmental impacts are to be reduced. Incentives and gold, silver or platinum ratings must complement this system.

The scope of green buildings in a green rating system is restricted to a building site and its surroundings – whether this may be a single building or a cluster, neighbourhood or a township. Beyond this, environmental and town planning rules apply. There is a need for integration of environmental conservation regulations to be included in city and regional planning measures. Green must also become intrinsic part of the architectural curriculum.

**Green must address socio-economic disparities:** Green Buildings must also address the larger socio-economic issues such as slums and squatters. According to the Builders Association of India (D.L.Desai, Construction Industry – an overview,Indian Construction, vol 42, no. 8, August 2009), the construction Industry in India is growing at the rate of 12.9% contributing on an average 6.6% of the GDP during 2002-07 period. However, the Report of

the Technical Group on Estimation of Housing Shortage constituted in the context of preparing the Eleventh Five Year Plan document , estimates housing shortage as on 2007 to be around 24.71 million, and the housing shortage during the plan period (2007-12) including the backlog is estimated to be around 26.53 million. Most of this shortage is in the EWS (Economically Weaker Section) and LIG (Low Income Group) section which does not seem to be getting converted into economic demand due to lower affordability by the poor leading to slums and squatters in cities.

Thus, on the one hand, a huge shortfall of housing exists while on the other, we have a booming construction industry which not catering to this need, is still growing at a phenomenal rate. The Green Buildings that have emerged in the last 5 years have largely been a part of the commercial construction trend, which did not in any way contribute to providing housing for the poor. Examples of certified buildings include CII Godrej Green Business Center, Hyderabad, Wipro Technologies, Gurgaon, Grundfos Pumps India Pvt. Ltd. and L&T EDRC, Chennai and several others. Sustainable architecture is the ability to meet the demand of housing while minimizing the footprint of built structures and cities.

**Green must mean low-embodied energy of materials:** The green rating systems have created a new market for materials such as thermally superior glass, insulation and HVAC systems – materials which did not hitherto exist in the supply chain. Estimates by IIT Bombay (Reddy, Embodied Energy in Buildings, Department of Civil Engineering, Indian Institute of Technology, 2002) indicate that the energy for consumption of basic building materials ($2500 \times 10^6$) is likely to double by 2020. The report also indicates that the use of low-embodied energy building materials such as stabilized soil blocks and brick masonry is 1.35 to 4.25 MJ per brick. As compared to this, the materials used in modern green buildings such as aluminium and glass is 236.8 and 25.8 MJ per kg. Even cement, the most common material used in building construction, has an embodied energy of only 4.5 MJ per kg.

**Green must focus on design rather than technology:** Although technological breakthroughs such as the CFL and LED lighting systems have been responsible for improved energy efficiency, technology by itself is not a solution. It is an aid to design. A good example is the use of thermally superior glass which has almost become symbolic of modern green buildings. However, Victor Olgyay, one of the pioneers in Passive design in the 1970s proved that a shaded glass fenestration reduces heat gain by two-thirds. Besides, aluminium and glass combination used as façade have both high embodied energy as compared to cement and bricks.

**Challenges and the way forward:**

There are several examples of green buildings and developments that have not entered the scope of certification but have intrinsically used green values in design. In the outskirts of Bangalore, a community called BCIL TransIndus is built entirely of soil stabilized blocks, uses natural stack ventilation and minimum interventions in the landscape. The site is

developed by Biodiversity Conservation India Limited (BCIL), a real-estate development company applying ecological principles to their construction practices. With nearly 1 million square feet of green buildings to its credit, BCIL is the largest Sustainable Built Environment (SBE) Enterprise in India. Last year, BCIL was awarded the Sustainability Award for best organization for its development of eco housing in Bangalore, Goa and other cities of India by the Indian Green Building Council. Some of the features of their construction include use of natural light, locally available materials, passive cooling by earth air tunnels, water shed management and water recycling and so on. BCIL is the largest producer of soil stabilized blocks in Asia.

Designers can consider the following guidelines to make buildings green in addition to guidelines in the rating system:

**Become stewards of the land:** Architects must take responsibility for conservation of the site. Considering the contours of the land, its hydrology, vegetation, geo-morphology and fauna in the design of structures is imperative if the impact of the built structures is to be reduced. Design must aim to reduce the building's footprint and impact on a given site and to the larger ecosystem

**Passive Design:** Passive solar design or the bioclimatic architecture has been an important field of study since the 1960s Victor Olgyay's research on human thermal comfort with the invention of the (temperature and relative humidity) bioclimatic chart. In fact, the practice of bioclimatic architecture dates back to the beginning of agriculture and society almost 10,000 years and is visible in vernacular architecture around the world which was dependent on passive design in the absence of active measures such as lights, fans and air conditioners.

Knowledge of building physics is a vital tool and skill for an architect while having immense scope for enhancing design and form. It includes the principles of heat and mass transfer in buildings, which is studied with respect to orientation, materials, massing and finishing.

Building simulation tools such as Ecotect, IES and Energy Plus/Design Builder are tools which allow architects to simulate their buildings to find out if the orientation is ideal, design optimum shading devices, use appropriate building materials and even simulate the actual flow of ventilation and natural light in the building.

**Building as a self-sustaining organism:** Buildings can be designed to mimic organisms in Nature. For example, the palm tree has a most efficient plumbing system and there is no better known energy generating mechanism than the leaf of plants. Buildings must be designed to incorporate systems of waste-water treatment, solid waste management, rainwater harvesting and energy generation such that it becomes a self sustaining unit. Many buildings are designed to incorporate at least one of these systems. But the challenge is to integrate the design of the building with its service system.

Our study of the vernacular architecture in the Indian subcontinent shows that Indian vernacular architecture has been a sustainable model. From North to the South and East to West, the courtyard, for example is seen in the housing of people but with infinite variations to deal with the climatic zones of the country as also to accommodate its wide variety of culture and tradition. Now, as we study their forms, orientation and architectural elements and their use of materials, we can say with confidence that they had the least ecological footprint. Our search for green buildings must then begin here where design is capital. We cannot afford to hide its flaws behind the façade of modern technology.