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A STUDY ON NEED OF HOLISTIC METHODOLOGY FOR ASSESSMENT OF SUSTAINABILITY AND GREENNESS OF BUILDINGS IN INDIA

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ABSTRACT

Today world is facing major environmental challenges i.e. global warming, Ozone layer depletion, climate change, waste accumulation, resource depletion etc. Buildings are largely contributing towards environmental burdens either directly or indirectly in its life cycle. Over 50% of material resources taken from nature are building related. Over 50% of national waste production comes from the building sector. Construction sector in India emits about 22% of the total annual emission of CO2 resulting from the Indian economy. Out of the emissions from the construction sector, 80% are resulting mainly from the products/industrial processes of energy intensive building materials. Buildings also consume large quantities of energy in their operation. Energy use in buildings has grown in the last 20 years due to sheer increases in number of households and offices has increased service demand like more air conditioning, more computers, more appliances etc is significantly contributing towards increasing energy demand Hence in view of the emerging environmental concerns in the building sector, buildings cannot be treated as a low impact sector and it becomes extremely important matter to develop a holistic environmental impact assessment methodology for assessment of sustainability and greenness of buildings in India. This paper reviews the different methodologies as well as current practices for evaluating greenness and sustainability in Indian building sector and provides an insight on various tools developed across the world for evaluating environmental impact of buildings.

KEYWORDS: Buildings , Life cycle , Environmental burden , Assessment tool

Buildings are the largest single contributor to global GHG emissions; accounting for around one third of the global final energy use and 30 per cent of global energy-related carbon emissions (Urge-Vorsatz et al., 2012). Buildings are largely contributing towards environmental burdens either directly or indirectly in its life cycle. Over 50% of material resources taken from nature are building related. Over 50% of national waste production comes from the building sector. Sustainability in building sector has gained international attention .The terms like green buildings, sustainable buildings and environmentally responsive buildings are gaining importance worldwide These buildings may be defined as those which are constructed with the principles of Optimize Site Potential., Minimize Energy Use and Use Renewable Energy Strategies, Conserve and Protect Water, Use Environmentally Preferable Products, Enhance Indoor Environmental Quality Optimize Operations and Maintenance Practices[1]. Hence greenness may be defined as the property of a building by the virtue of which it uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. It is very important to assess the greenness of buildings by eventually evaluating the impact of buildings on different components of environment.

METHODS TO EVALUATE GREENNESS OF BUILDINGS

The methods to evaluate greenness of buildings may be classified as follows:

Single Parametric Approach

Under this approach buildings are assessed based on single attributes like Embodied energy, CO2 emissions, energy efficiency, recycled green materials/products etc

Multiple Parametric Approach

In this approach buildings are assessed on attributes. Various Green building rating systems have been developed based on multi-criteria standard in which points are earned in various areas like Sustainable Sites , Water Efficiency ,Energy & Atmosphere , Materials & Resources, Indoor Environmental Quality, Innovation & Design Process, Regional Priority.etc.

Life Cycle Assessment (LCA) Approach

ISO 14040 defines LCA as technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by

- Compiling an inventory of relevant energy and material inputs and environmental releases
- Evaluating the potential environmental impacts associated with identified inputs and releases

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- Interpreting the results to help decision-makers make a more informed decision ensuring greenness of building and sustainability of resources

Countries all around the globe are focusing on developing tools for measuring the environmental impact and sustainability of buildings. A number of evaluation tools has been developed by different countries to assess the environmental impact of buildings but are more relevant to the conditions specific to their own countries. The tools are broadly classified as assessment tools which rates buildings based on certain set of criteria and are qualitative whereas others are termed as evaluation tools which evaluates buildings on quantified values of environmental impact. Some of these tools are separately shown in table 1

Table 1: Environmental Assessment/rating tools developed across the world

Assessment Tool	Assessment Level	Environmental Attributes
ATHENA EIE	Material, assembly & whole building	Material/resource, transport, energy, environmental loadings.
BEAT	Material & Assembly	Waste, Energy, Water, environmental loadings.
BEES	Material & Assembly	IEQ, Energy, Water, Environmental loadings
BREEAM	Assembly & whole building	IEQ, material resource, transport, energy, water, environmental loadings, biodiversity.
CASBEE	Whole Building	IEQ, material resource, transport, energy, water, environmental emissions
ECOPROFILE	Whole Building	IEQ, material resource, transport, energy, water, environmental emissions, biodiversity.
ECOQUANTUM	Material & Assembly	Material/resource, energy, environmental emissions.
ENVEST	Whole Building	Material/resource, energy, water, environmental loadings.
EQUER	Assembly & whole building	Waste, energy, water, environmental loadings.
GB Tool	Whole Building	IEQ, material resource, transport, energy, water, environmental loadings.
Green Globes	Whole Building	IEQ, material resource, transport, energy, water, environmental loadings.
GreenCalc	Assembly & whole building	Material/resource, transport, energy, water.
LEED	Whole Building	IEQ, material resource, transport, energy, water, environmental loadings, biodiversity.

Source : Technical evaluation of environmental assessment rating tools by S.seo et-al

SHORTCOMINGS OF RATING SYSTEMS

The rating systems have following shortcomings:

A. These rating systems certify a building based on points scored on fulfilling the fixed set of environmental criteria
B. Looks only at prescriptive design, not measurable performance
C. Too complicated, bureaucratic and expensive
D. Subjective nature of scoring system makes it difficult for those models to provide in depth results as they are not derived based on a systematic study of environmental impact related to the factors concerned
E. There is far too little monitoring data available to confirm claims made.
F. They focus more on energy efficiency and "end-of-life" (dismantling and waste disposal) of the materials are considered rather vaguely.
G. There exists a major uncertainty in knowing whether these labeling systems really do ensure that buildings are "green". These rating systems hide the real mass and energy flows which are critical in the determination of effective environmental impacts. They do not help to reveal the carrying capacity of the environment.

RECOGNITION OF LCA

LCA methodology is gaining recognition globally as an effective approach due to following advantages:

A. LCA based methods compared to scoring methods, demonstrate an in depth coverage of environmental impacts associated with design and building material

B. LCA is one of the well known tools for analyzing the environmental impacts of a product through its entire life from cradle to grave, i.e., from raw material extraction, through manufacture, usage phase, reprocessing where needed, to final disposal.

C. LCA is applicable for all the stages of building and finding out the important alterations to maximize the performance of building.

D. Life cycle assessment has a solid and robust scientific background which helps in converting science into insight for decision making

E. Life cycle assessment (LCA) covers a wide range of environmental aspects like energy analysis, carbon appraisal impacts on human health (climate change, ozone depletion smog, toxicity, etc.), impacts on ecosystem quality (acidification, eutrophication, toxicity, etc.), impacts on resource availability (depletion of minerals, fossil fuels, etc.)

INDIAN BUILDING SECTOR

Background

Construction sector in India emits about 22% of the total annual emission of CO_2 resulting from the Indian economy. Out of the emissions from the construction sector, 80% are resulting mainly from the products/industrial processes of energy intensive building materials,[13] Buildings constructed in India consumes varieties of materials like cement, crushed stones, sand, steel, bricks, timber etc..Most of the building materials are manufactured using natural resources like limestone, iron-ore, coal, gypsum, bauxite, wood etc. Apart from this, crushed stones, river sand and local soils are also consumed heavily. The introduction of tiles, paints, putty, glass, PVCs , aluminum etc. and latest interior finishes have added new dimension to the buildings . At the same time it has caused serious environmental problems. there is an increasing requirement of these materials, particularly in housing, which accounts for nearly 60% of the materials consumed by the construction sector annually [14] Therefore, the choice of building materials represents a sensitive process that can have many negative consequences and effects on direct users, but also on the complete environment Fig-1 shows the percentage share of various building materials consumed in construction of a typical residential building constructed by a state housing construction agency at Raipur city of Chhattisgarh state in India.

Indian building sector is moving at a faster pace. The overall constructed area of India in 2005 has been estimated to be close to 21 billion square feet and is expected to swell to around 5 times of this size and reach to approximately 104billion square feet by 2030 adding 83 billion sqft. Moreover "By 2025, the retrofit potential of existing buildings in India is worth USD 25 Billion," [According to report compiled by the Environmental Design Solutions Pvt Ltd. (EDS), a New Delhi based Consultancy agency]. Also by 2050, it is projected that India will see an unprecedented escalation of floor area of around 400% (Urge-Vorsatz et al., 2012) that will further add about 35 billion m2 (321.36 billion sqft) of new building floor area. This will raise the consumption of the amount of building materials, raw materials , water and energy that will consequently increases the environmental load. Another important and alarming issue of Indian building sector is energy consumption. Buildings are responsible for around 35% of India's total energy consumption, and this is increasing by 8% year-on-year (Rawal, Vaidya, Ghatti& Ward, 2012) Providing basic housing to all of its citizens will require a 3 to 4 fold increase in primary energy supply and a 5 to 6 fold increase in electricity generation by 2030. [15]Energy use in buildings has grown in the last two decades Sheer increases in number of households and offices has increased service demand like more air conditioning, more computers, more appliances is significantly contributing towards increasing energy demand as well. Fig-2 shows the percentage share of operating energy of a residential building [16]. The residential building stock will increase its energy use by around 800% and CO_2 emissions by 840% compared to the baseline year of 2005[17].This shows that without a transformational change, energy consumption of buildings will increase to levels that are unsustainable and threatening to India's energy security.The Central Electricity Authority (CEA) indicates that India will see an electricity shortage of 9.3% and peak demand shortage of 10.6% (CEA, 2012). Energy consumption based on fossil fuels and related carbon. This translates to a potential growth in energy related GHG emissions .India is a country of varied geographical and topographical regions with highly diverse cultural setup. Moreover residential buildings are expected to have a very broad bandwidth given the range of low cost housing to high income housing With an exponential growth in the construction industry of the rapidly developing countries, there is a great need to develop such a tool that will assess and quantify buildings environmental impact

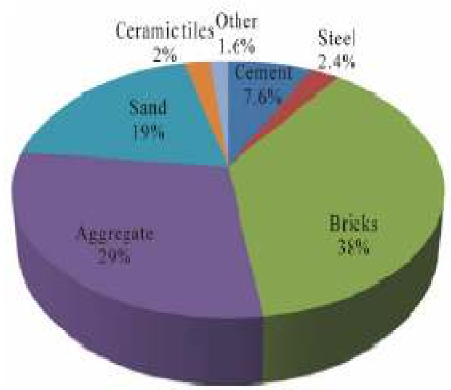

Figure 1: Share of different materials by weight used in a residential building of for 1 m^2 (gross floor area)

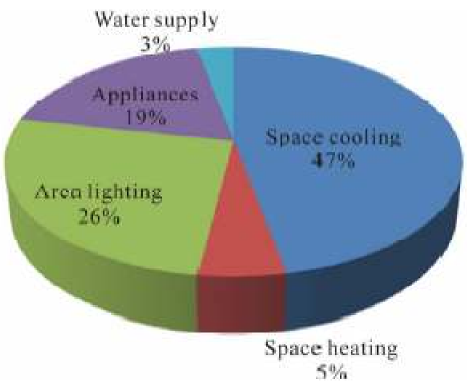

Figure 2: Operating energy distribution by activity

Assessment Tools For Indian Building Sector

Energy Conservation Building Code (ECBC)

Energy Conservation Building Code (ECBC) is designed to promote only energy efficiency in commercial buildings. It is a voluntary programme and confined to only commercial buildings with a minimum of 100 KVA load. According to BEE most commercial buildings in India have Energy Performance Index (EPI) of 200 kwh/sqm/year or higher. BEE considers 180 kwh/sqm/year as the typical national average and states that the buildings in North America and Europe have EPI of less than 150 kwh/sqm/year due to overall efficiency gains.

ECBC sets minimum energy efficiency standards for design and construction of commercial buildings for the following cases

Connected load in excess of 100kW or Contract demand in excess of 120 kVA. Also applies to Additions and Major Renovation When addition + existing building area > 1000 m2 Renovated portions and systems of a 1000 m2 or larger building.

Scheme for Rating of Buildings

- The Star Rating Program for buildings is based on specific energy usage (kWh/sq m/year) considering actual performance of the building.
- This programme would rate buildings on a scale with 1-5 star .5 Star labeled buildings being the most efficient.
- Five categories of buildings - office buildings, hotels, hospitals, retail malls, and IT Parks in five climate zones in the country have been identified.

Environmental Impact Assessment (EIA)

Under the Environment (Protection) Act, 1986, Environment Impact Assessment rules were introduced Though this tool is meant for only large construction projects with area more than 20,000 sq meters,. But the partial data available only for a few states indicate that EIA clearance for buildings in a year with huge area coverage is good in number , but other specific building regulations that have a direct bearing on the resource use are mainly sectoral in scope and often singularly confined to only either water, or energy, or waste management and are mostly voluntary in nature. The ECBC and environmental clearance methods are designed only for commercial buildings.

LEED India

The IGBC (Indian green building council) has launched LEED India for Existing Buildings (EB), New Construction (NC), Core and Shell (C&S) and Indian Green Building Council (IGBC) Green Homes, which represent the measurable indicators for global and local concerns in the Indian scenario. It is Effective in India from 1st Jan 2007 It is based on professional reference standards like NBC, ASHRAE, and ECBC etc. and assessment is done by 3rd party assessors & USGBC. Based on the points achieved, the building may be eligible for LEED certified, Silver, Gold or Platinum Rating. All the IGBC rating systems are voluntary, consensus based, market-driven building programmes. LEED® India Green Building certification is given on the points earned for individual credits.

LEED® India Green Building Rating System

Sl. No	Credits	New Construction	Core & Shell
1	Sustainable Sites	13	14
2	Water Efficiency	6	6
3	Energy and Atmosphere	17	14
4	Materials and Atmosphere	13	14
5	Indoor Environment Quality	15	11
6	Innovation and Accredited	5	5
	Total	69	61

LEED Certification level

S.no.	Rating	Points
1	LEED Certified	26-32
2	LEED Certified Silver level	33-38
3	LEED Certified Gold level	39-51
4	LEED Certified Platinum	52-69

Green Rating for Integrated Habitat Assessment

Green Rating for Integrated Habitat Assessment GRIHA has been developed as National Rating which takes into account the provisions of the National Building Code 2005,the Energy Conservation Building Code 2007 announced by BEE and other IS codes, local bye-laws, other local standards and laws. It is the national green building rating system for India, endorsed by the Ministry of New and Renewable Energy (MNRE), Government of India (GoI).. It comprises a set of 34 criteria addressing sustainable site planning, optimized energy performance, use of efficient materials and construction practices, integration of water and waste management strategies, indoor environmental quality and; health, comfort and safety of human beings. It is a 100+4 point system where differential weighting is allocated on various criteria It provides a rating of up to five stars for green buildings

GRIHA Certification level

S.no.	Rating	Points
1	One star	50-60
2	Two star	61-70
3	Three star	71-80
4	Four star	81-90
5	Five star	91-100

CONCLUSION

The construction industry of India has a huge capacity to participate in the development of a sustainable built environment ensuring sustainability of resources. The residential buildings have been creating significant social and economic values, therefore it becomes necessary to consider the environmental impact of a buildings considering all three aspects of sustainability viz environmental economical and social. . ECBC and EIA method did not cover residential buildings which have a very broad bandwidth given the range of low cost housing to high income housing . Overall the residential sector in India is a significant user of primary energy. Building rating systems have been instrumental in raising awareness and popularizing green design. However, they fail to involve an assessment of the combined impacts of the various individual measures promoted by the guidelines – the actual or projected impacts of the completed building throughout its whole life cycle on the local, regional, and global environment. LCA methodology will help in taking informed decisions by various stakeholders with a view to strategy planning, the establishment of priorities, the design or refurbishment of buildings, the selection of suppliers and materials, the establishment of strategies to manage residues, taxation policy, etc. addressing the greenness and sustainability aspect of building construction. It will emphasize on home building community to focus more attention on environmentally sustainable building by encouraging the development of innovative home designs, building methods, and technologies, eco friendly materials, recycling and reuse to reduce material, energy and water consumption to lower environmental impact and improve sustainability at a local, regional and global level and also to improve residential comfort and safety over the complete life cycle of the building For a country like India which ranks 2nd in population fulfillment of even the basic needs requires huge resources.. In order to assess greenness and sustainability of buildings it is necessary to accurately determine the influence on the environment from building-related activities through a building's entire life cycle, including its architectural and structural design, construction, operation, and demolition based on quantitative values of impact. Without measurement there is no management. If we don't develop the tools that quantify the environmental impacts, we can't design a building that is verifiably green and sustainable. Thus we require a measurable instrument that holistically assesses impacts of water, energy, land usage and generation of wastes of buildings for assessment of greenness and sustainable building practices covering entire life spectrum of building to reduce the overall damage for which life cycle assessment approach can play an important and effective role for Indian building sector.

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