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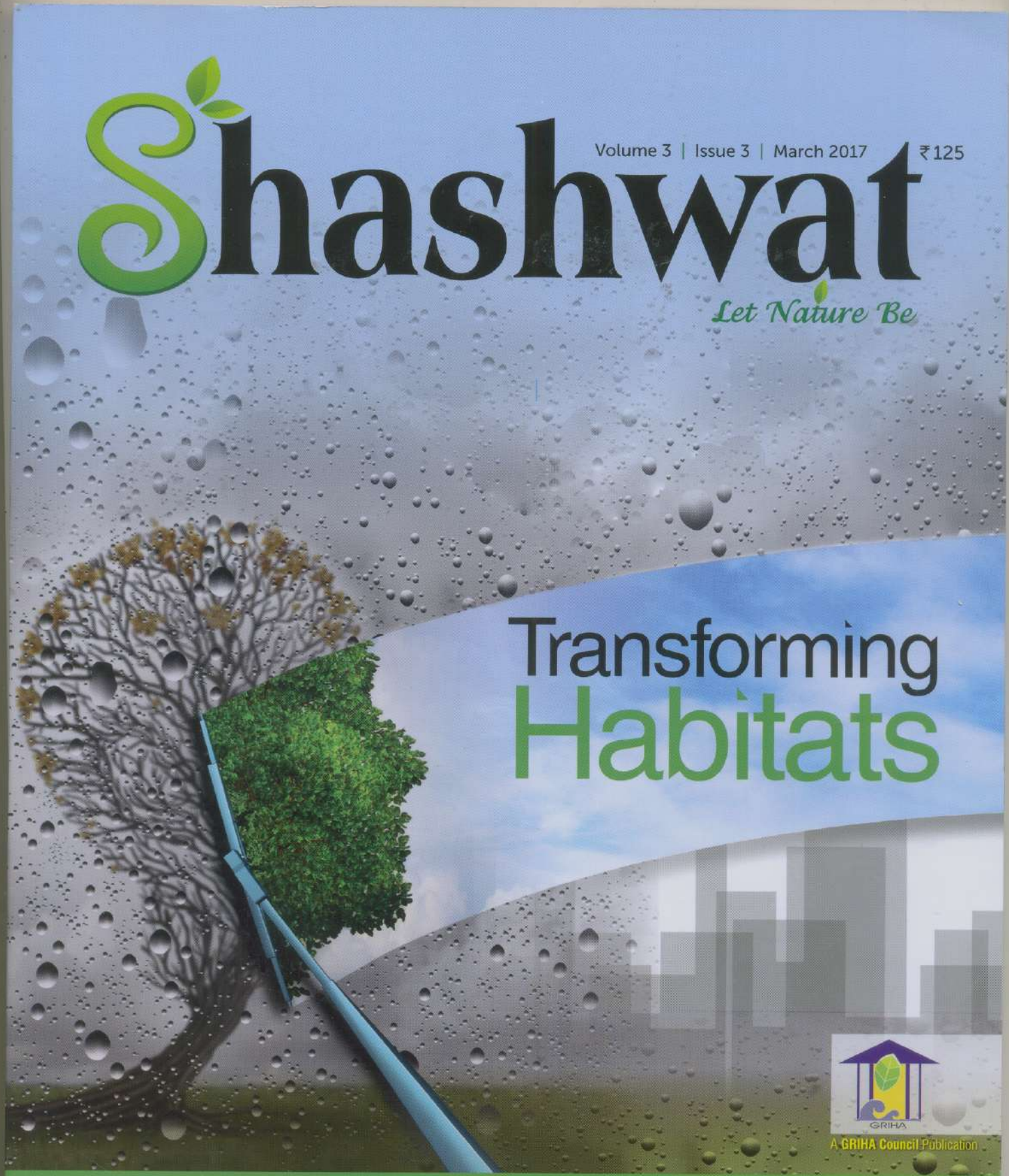
Shashwat

Let Nature Be



Transforming Habitats

A GRIHA Council Publication

Feature Articles
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SVA GRIHA 5 Star:
Design Associates Inc. Office

MAINSTREAMING GREEN BUILDINGS

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Although sustainability has been integral to the country's varied and vibrant vernacular architecture, its emergence as a measure to evaluate buildings is a recent phenomenon in India. Built in response to the climate, natural features and resources of the site, as well as the socioeconomic fabric and traditions, it is a holistic building design which has been created keeping in mind urgent concerns of the environment and ecology.

Conventional buildings often consume huge quantities of material and natural resources, deplete non-renewable resources, have high-embodied energy, and pollute the air, water, and soil in the process of manufacture. The indoor environment quality in these buildings is also a major concern. They lack the checks and balances inherent in vernacular design.

More than a decade since the introduction of green buildings in India, we can boast of several green building rating systems including the national green building rating system, GRIHA. These ratings have addressed environmental concerns broadly in five major areas, namely, site planning, energy efficiency (including passive design), water and waste management, building materials, and indoor air quality.

However, despite a steadily growing footprint—and being identified as one of eight investment opportunities in the construction sector by the central government's 'Make-in-India' campaign—green buildings are still not part of the mainstream.

Current Challenges and Gaps

Integration of Green Building Codes

India is largely a self-built country. Architects contribute between 2–5% of building design and construction mainly in urban areas in an economy in which building construction contributes 8% to the GDP and employs more than 35 million people. Single-dwelling units across the country are mostly constructed by owners with little or no technical inputs, while the vast majority is executed—even designed—by untrained contractors. There is barely any research or survey to study and address this situation.

Existing green building standards and benchmarks are voluntary, that is, these are design

codes that provide guidelines for setting the building, design of the building's envelope, water and waste management, improvement of indoor air quality, lighting systems, Heating Ventilation and Air Conditioning (HVAC) systems, as well as electrical and use of renewable energy. Moreover, there is little or no incentive from the government for project developers to implement these standards. There is no sufficient awareness generated or information that can be provided to indicate the long-term benefits and lifecycle cost analysis of green buildings.

Voluntary green building codes are not sufficient if green buildings are to be scaled up. Integrating the green building standards and codes into the Development Control Regulations (DCR), and other building planning and design process, is important for these criteria to become a part of standard practice.

Outcome-based Compliance Approach

Most of the existing green buildings rating system criteria are prescriptive in nature, that is, they specify required minimum or maximum values for discrete components or features of a building. For example, the prescription of using a dual flushing cistern in toilets or for the HVAC system to have a certain minimum Coefficient of Performance (COP), are prescriptive criteria. Some other criteria are based on modelled performance paths such as the simulation for a building that achieves a certain projected day lighting level or energy usage per square metre. Few benchmarks are outcome based and test the actual performance of a building in use.

An outcome-based approach is not concerned with the approach. For example, it will not specify what window to wall area ratio should be for the envelope of a green building, but rather the building does not consume energy beyond a certain level. The energy performance index is one such outcome-based measure (the unit of which is kWh/m²/year). For example, the Bureau of Energy Efficiency (BEE) awards star ratings to buildings on the basis of their EPI. The designer or developer has to ensure that the building meets the specific output standards as specified in the code, whether it is related to water, waste, or energy.

Unlike a prescriptive approach, an outcome-based approach will have direct quantifiable environmental benefits and can provide a better understanding of factors, such as user behaviour, occupancy patterns, commissioning, and maintenance (Yu, Evans, and Delgado 2014). Its implementation will require serious thought about the benchmarks specified, methods of assessment, as well as the penalties that could be imposed.

Alternative to Conventional Building Materials

Raw materials of commonly used building materials are finite and either mined from deep within the earth or extracted from quarries. Limestone, Silica, Coal, Iron ore, and Alumina, and even topsoil for bricks, are limited. The extraction and processing of building materials involve energy-intensive processes such as smelting and calcination while transportation is another source of greenhouse gas emission. Materials such as steel can be recycled; however, the energy involved in recycling is considerable. The availability of sand for use in concrete is already a serious concern in many towns and cities. Recycled debris, quarry waste, and manufactured sand have been suggested as alternatives.

Carbon dioxide emissions from fossil fuel use and cement production accounted for 2,100 million tonnes in India in 2014. Forty per cent of the CO_2 emissions from the production

Table of BEE rating for office building less than 50% air condtioned build-up-area

EPI KWH/SQ.M/YEAR	Star Label	EPI KWH/SQ.M/YEAR	Star Label
80-70	1 Star	85-75	1 Star
70-60	2 Star	75-65	2 Star
60-50	3 Star	65-55	3 Star
50-40	4 Star	55-45	4 Star
Below 40	5 Star	Below 45	5 Star

Composit

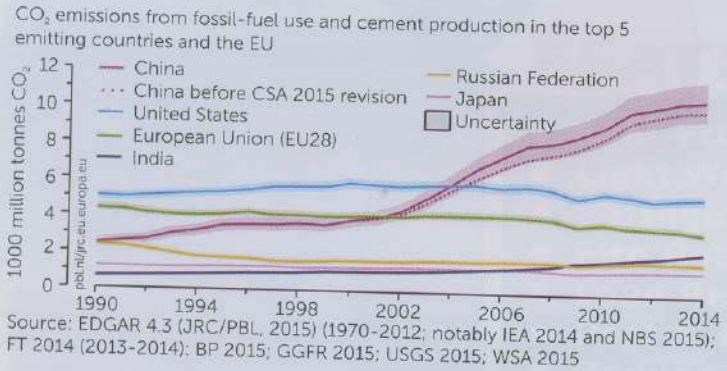
EPI KWH/SQ.M/YEAR	Star Label
75-65	1 Star
65-55	2 Star
55-45	3 Star
45-35	4 Star
Below 35	5 Star

Warm and Humid

Hot and humid

Figure 1: BEE Star Rating for Buildings with Less than 50% Air-Conditioned Space
Source: Bureau of Energy Efficiency

Figure 2: Fly Ash, Slag and Silica Fume offer environmental and Performance benefits when optimally combined with portland cement in concrete mix designs
(Source: America's Cement Manufacturers (2015); Using Concrete as a Sustainable Solution for Buildings)



Source: EDGAR 4.3 (JRC/PBL, 2015) (1970-2012; notably IEA 2014 and NBS 2015); FT 2014 (2013-2014); BP 2015; GGFR 2015; USGS 2015; WSA 2015

Figure 3: CO_2 Emissions from Fossil-fuel use and Cement Production in the top 5 emitting Countries and the EU.

of cement is on account of combustion and 60% on account of calcination of limestone (along with clay, iron ore, sand, alumina, iron, and silica) at 2,700°F in a clinker. Alternative fuels in place of coal for combustion, such as waste oil, solvents, scrap items, and municipal solid waste can reduce this impact.

The bulk of building material is presently derived from locally available clay, soil, sand, and gravel. Solid fired clay bricks are the most widely used walling materials in the country. However, over the past few decades, the development of other materials, such as solid/hollow concrete blocks, fly ash bricks, Cement Stabilized Soil Blocks (CSSB), Fly Ash Lime Gypsum (FaL-G) blocks, Autoclaved Aerated Concrete (AAC) blocks, etc., has created viable alternatives to bricks that have also penetrated the market.[1]

Many more alternatives to both external and internal building materials are required so that builders and designers have an array to choose from. This will require R&D on walling, roofing, and other building materials on a war footing. We need materials and techniques that have low embodied energy, are recyclable or biodegradable, and have lower impact on air, water, soil, as well as indoor environment quality.

Interdisciplinary Approach in Environmental Education

To meet the challenges of environmental sustainability, we need people with technical and human skills that transcend conventional disciplines of architecture, civil engineering, environmental science, and communication. These boxed divisions, in an effort towards more and more specialization, have created watertight compartments while environmental sustainability demands a holistic approach. Gated disciplines generate graduates who are not able to tackle complex challenges such as answering human needs while maintaining the integrity of the supporting ecosystem.[2]

Many researchers are, therefore, calling for a pedagogical shift from education that encourages knowledge and skill accumulation to an education which is based on facing real-life complex problems. They call for education that encourages contextual understanding of the physical sources together with human values and perceptions that caused the problem. There is a quest for education that will teach students that it is their professional responsibility to lead towards sustainable change.[3]

The field of sustainability may be perceived as a new field created from the combination of many traditional fields. This abundance is a fertile ground for innovation, which can be intensified through academic collaboration with organizations and industries.[4]

Changing Human Behaviour: The Key

Today, most attempts to mitigate the effects of environmental impact on the construction industry focus mainly on technological developments that

1 'Strategies for Cleaner Walling Material in India'.

2 Epilogue: 'Ecological Literacy'

3 'Currents in Environmental Education: Mapping a Complex and Devolving Pedagogical Field'

4 'Why Sustainability Is Now the Key Driver of Innovation'

improve the efficiency of building systems and performance of building mechanical systems and electrical systems. However, more and more evidence suggests that these actions are insufficient in our struggle to decouple buildings from wielding a destructive impact on the environment.

In recent years, a new environmental approach has started to develop that advocates measures focussed on the consumer rather than the continued encouragement of the producers to adopt constant technological innovation. Efforts on technologically advanced building systems can continue but designs that trigger change in human behaviour and attitude is required, because even the greenest of buildings need environmentally sensitive and proactive inhabitants to achieve sustainability targets.

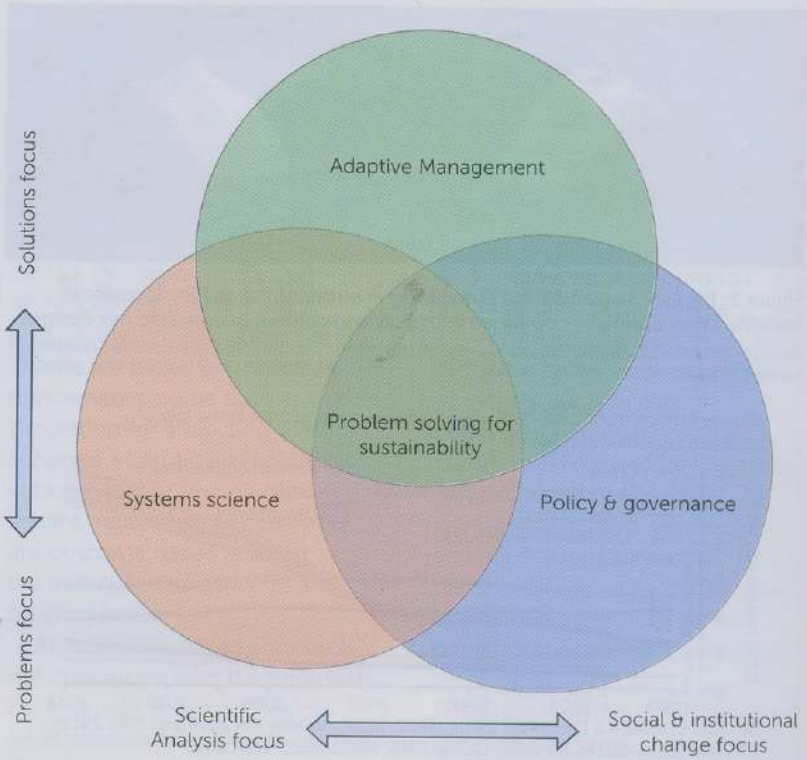


Figure 5: Framework for Understanding Interdisciplinary Environment Education
(Source: Vincent, S., & Focht, W., (2011). Interdisciplinary Environmental Education: Elements of field identity & curriculum design)

Conclusion

Mainstreaming green buildings will require a manifold approach and strategy. Environmental awareness will generate demand and thoughtfully designed curriculum can generate skilled professionals ready to take on green jobs. Policies and regulations are required to favour the easy integration and application of green building codes. The existing codes, criteria and rating systems while enlarging their footprint need to simultaneously develop credible and quantifiable environmental benefits.

A glimpse from student training programme held at Indian Institute of Technology, Roorkee, September 2016.