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Sustainable construction and green buildings on the foundation of building ecology

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There can be few aspects of construction which in recent years have attracted greater attention than sustainability and this trend is likely to gather momentum as general awareness of matters relating to environment increases. Although sustainability is generally defined as the extent to which the current needs can be fulfilled without compromising the needs of future generations, the problem arises with the sense of 'needs', as it turns out to be an entirely subjective term which involves judgements mainly relating to standards of living. If one compares how life styles compare now with pre-industrial revolution period, the changes will be felt as enormous. At that time, even in relatively developed countries, human needs were largely fulfilled by supplies from the local environment; this is obviously not so today even in the developing countries, that are trying to emulate the living standards of the developed world. This in hard numbers means continuous per capita energy consumption of about 2 kW throughout life.

As far as 'future' is concerned the time scale over which 'needs' might be considered is also difficult to identify. Governments, for example, tend to focus on terms which by and large coincide with their terms in office, i.e., 5-10 years. Individuals may be mainly concerned with time scales concerning their immediate descendants, which may be of the order of 20-30 years.

When viewed in the context of the above time frames, it is difficult to contemplate what might be regarded as 'future needs'. Current perception probably focuses more upon a rate of advancement of expectation in standard of living rather than a need at a particular point of time.

Further, there are other sustainability issues of great significance such as the adoption of green hierarchy (reduce – re-use – recycle – recover – dispose), implication of energy types as well as embodied energy values in materials for human consumption.

All these sustainability issues have become extremely critical in the way buildings, built environment and the process of building juxtapose with the ecosystem. It is broadly estimated that buildings worldwide consume about 40 per cent of the planet's materials resources and 30 per cent of its energy. The construction of buildings is reported to consume 3 billion tones of raw materials per year and generates between 10 and 40 per cent of the solid waste streams in most countries. The manufacture of many of the materials used in buildings require the consumption of large amounts of energy derived from the fossil fuels and the displacement of mega-tonnes of earth during the course of mining. The energy input in GJ/tonne for aluminium is 190, plastics 80-100, steel and other metals 30-50, glass 20 and cement/concrete

products 1.3-5. But for every tonne of cement produced about two tonnes of raw materials must be mined; nearly one tonne of carbon dioxide and upto 6 kg of NO_x gas are produced. Building, therefore, contributes significantly to global ecological degradation and greenhouse gas emissions.

If we want to sustain our urban future there is no option but to build in ways that not only reduce environmental damage but which improve the health of ecosystems and protect natural resources.

Green building

The essential requirement in this respect is to adopt the "green building" practice. It is a process to create buildings and infrastructure that minimize the use of resources, reduce harmful effects on the ecology and create healthier environments for people. Green buildings are expected to exhibit a high level of environmental, economic and engineering performance that include :

- Energy efficiency and conservation
- Improved indoor air quality
- Resource and material efficiency
- Occupant's health and productivity
- Proximity to public transport system
- Improved environmental quality covering air, water, land and ecosystems.

There are different criteria that are applied to choose materials that can be used in green buildings. They include materials made of recycled and salvaged agro-industrial wastes; materials that reduce the quantity used without sacrificing the durability, materials that are biogradable, materials with low emission of volatile organic chemicals (VOC), materials that avoid toxic emissions or does not add to the ozone depletion, natural and minimally processed products, alternatives to natural wood but not made of PVC, products that reduce or minimize pesticide treatments and reduce pollution; products that reduce environmental impacts during construction, demolition, renovation or retrofitting, materials that save energy and water and so on.

Life cycle assessment

While there are many different approaches to the detailed evaluation of construction materials, in environmental performance terms there is little disagreement as to aspects of performance which should be definitely considered. Comprehensive assessments of materials performance must be in the context of complete life cycle (life cycle assessment, LCA).

An LCA considers the following aspects :

- Extraction, processing and transportation of raw materials;
- Production, transport and distribution of resulting products;
- Use, re-use and maintenance;
- Recycling and final disposal.

The European division of the Society for Environmental Toxicology and Chemistry (SETAC) describes the purpose of LCA as a process designed to :

- Evaluate the environmental burdens associated with a product, process or activity identifying and quantifying use of energy, materials and waste discharged into the environment;
- Determine the impact of these resources and waste and their environmental discharges; and
- Evaluate and put into practice, opportunities for improvement.

Manufacturing companies like BMW and Philips use LCA to re-engineer many of their components and manufacturing operations. Building product manufacturers such as BHP Steel, Boral and James Hardie have now applied LCA to some of their building products and have compiled databases which detailed their life cycle environmental loads. LCA has also become an important marketing tool for companies who can now tender for projects that require high environmental standards.

Apart from realizing the commercial benefits of LCA, the visible benefits of green building practices have prompted the establishment of many other initiatives by building companies, governments and communities worldwide. The years since 1992 have seen, for example, the establishment of environmental industry bodies like the US Green Building Council, the UK's Association for Environmentally Concious Builders, the Australian Building Energy Council and similar organizations

in countries like Canada, the Netherlands, Japan and South Africa.

Green building initiatives in India

In India the concept of green building came into being with the CII – Godrej initiative in 2006, when the Indian Green Building Council was formed. The council is represented by all stakeholders of the construction industry – corporate bodies, governmental agencies, architects, material manufacturers, relevant research bodies and academia, etc. The vision of the council is to serve as a nodal point to facilitate green building activities in India. The council has reportedly set the following tasks :

- Catalyse 100 green building per year by end 2012.
- Set on stream 10,000 committed building professionals by 2012 to help realize green building concept.
- Develop a robust green building rating system.
- Help achieve at least 4-5 per cent cost reduction in making green buildings as compared to similar conventional buildings.

The green buildings concept is poised to become a movement in India. The Green Business Centre Building at Hyderabad has received "Platinum" rating and this has sensitized the stakeholders in the construction industry. Green buildings are being planned more extensively by the corporate bodies – both in the private and public sectors. The available statistics indicate that from a humble beginning of only 1860 sq.m. of green foot print in 2003, the country touched 6500 million sq.m. of green building by 2006. The growth trend continues.

Green building guide

While constructing green buildings, the availability of appropriate materials and equipment is one of the essential issues to be addressed. Prior to 1996 much of the written information offered only complex numerical assessments that proved difficult for designers and clients to interpret. One of the early attempts to simplify the procedure for rating green construction materials was the publication of a handbook on Green Guide by Building Research Establishment, UK in 1996. Since 1998 the Green Guide has been a part of BRE Environmental Assessment Method (BREAM). The Green Guide to Housing Specification brought out by BRE in 2000 is an accredited environmental rating scheme for buildings. The environmental issues considered reflect the generally accepted areas of concern such as climate change, fossil fuel depletion, ozone depletion, human toxicity, waste disposal, water extraction, acid deposition, ecotoxicity, eutrophication, seasonal smog and mineral extraction. Although the environmental ratings are underpinned by extensive quantitative data, it was felt that these numerical values and comparisons would be of interest to specialists rather than those involved in the day-to-day management of building projects. These data have therefore been translated into a simple environmental rating system to enable specifiers to make meaningful comparisons between materials and components. As a means to this end, an A,B,C ranking system is used, where A equals least environmental impact and good environmental performance, with B and C ratings increasing in their environmental impact. Finally, BREAM is a design and management stage assessment tool that provides a credible, transparent, environmental label for buildings based on good practice.

Quite in line with the aforesaid developments in UK, the growth of the green buildings concept in the US has also been significant. It is reported that the market for green building materials was expected to continue growing from almost $2.2 billion in 2006 to $4.7 billion in 2011. This forecast was obviously made prior to the present unforeseen economic downturn. The US Green Building Council has its own brand of rating system which has been the basis for IGBC adopting the programme of Leadership in Energy and Environmental Design (LEED).

It may be interesting to note that IGBC has been working on LEED – India programme for the last 2 years, having launched it in January 2007. Attempts are also being made to indigenize the rating system by incorporating more emphasis on water conservation and adoption of Indian Codes and Standards. The guidelines of National Building Code, Ministry of Environment and Forests, etc. are being increasingly incorporated. Materials such as flyash based blocks, recycled flooring tiles and false ceiling, low VOC paints, bamboo products, solar PV, high efficiency light sources, dual-flush cisterns, etc. are being encouraged more and more.

Against such national and international developments of green building programmes, what you see in and around some of our cities, are the awfully conventional products and practices at the construction sites. You still stumble upon mounds of sand and aggregates heaped on the streets and lanes close to places where construction activities are taken on hand. You still find

ready-mixed concrete as a product-in- promotion and not as a mandatory requirement of any construction project. You still undergo the unbearable noise pollution, if you happen to be in proximity to a project site. The fly ash based bricks and blocks continue to be a product-in-doubt. Recycled building products are untouchable. We are thoroughly unmindful in this part of the country of the fact that how to-day we build our homes, both in design and choice of materials, is one of the most important ways to shape our future.

Building ecology

An effective campaign for green building practices is called for. But the campaign will unlikely to succeed, if we fail to recognize the need to train up the budding engineers and young professionals in "building ecology". This discipline shall empower the engineers to conceive, nurture, promote and facilitate the kind of changes in building practice that are necessary to contribute to sustaining our life-supporting environments. This discipline is broadly spread over five facets. The first and foremost is the "knowledge of interdependency". It enriches the engineers with the concept that what they build establishes flows of material and energy that affect the present and future environments and people. The second facet bestows on them the "knowledge of conservation and efficiency" which teaches them that energy and matter are not created or destroyed and therefore, in construction they should not be wasted. The third facet of building ecology is the "knowledge of surviving designs", which are based on the second and fourth laws of thermodynamics. They ensure that energy used should preferably be renewable; it is used in a large number of small steps rather than in a small number of large steps. They create systems that use the outputs of consumption as resources for production. The fourth facet of building ecology is the "knowledge of natural systems". It imparts them the understanding that life is sustained by the constant cycling of materials from the Earth, through plants and animals, to the atmosphere and back through the Earth. The design decisions address the imbalances in biogeochemical flaws caused in construction and their buildings help support the diversity of ecosystems. Finally, the fifth facet of building ecology deals with the "knowledge of change". The engineers need to learn that the only certainty is that conditions always change. They need to understand that a sustainable building is not one that last for ever but one that can easily adapt to change. They should apply their life-cycle thinking to create buildings that are resilient to environmental conditions and can cater to a diversity of human needs, minimize resource consumption and waste generation along with avoidance of obsolescence.

There is perhaps a need for a culture change towards greater flexibility in building designs and construction practices. There is an imperative need for appreciation and adoption of building ecology. Let all real-estate and infrastructure developers focus on the practice of increasing the efficiency with which buildings use resources – such as energy, water and materials, - while reducing building impacts on human health and environment through better design, construction, operation and maintenance. Let all real-estate and infrastructure developers go green.

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