ReBuild

Vol. 4 No. 3 (Jul-Sep 2010)
A Quarterly Newsletter

SUSTAINABILITY
AND
GREEN BUILDING

Dr. Fixit Institute
of Structural Protection & Rehabilitation

A Not-for-Profit Knowledge Centre

Building Ecology - First Principles for a Sustainable Built Environment

As we all know, ecosystems are life-supporting systems and buildings that can be sustained by ecosystems rather than damage them are urgently required. Modern science is providing a far more detailed perspective of the way ecosystems function. This new knowledge is now beginning to be used by the building professionals and the building industry. "Building ecology" according to Peter Graham, has emerged as a discipline that presents approaches to gaining knowledge about the environmental influences of building in a holistic framework. It is supposed to help students of building professions and practising engineers to understand :

- The interdependence of building and nature;
- How buildings affect nature;
- What is and what is not sustainable;
- How the building activity can coexist with nature.

It was reported in the World Watch Paper No.124 in March 1995 that buildings worldwide consume about 40% of the planet's materials resources and 30% of its energy. It is quite likely that these estimates might have appreciably increased in the last 15 years with ever increasing building activity and urbanization.

In the year 2000 it was estimated that the construction of buildings was consuming raw materials at the rate of about 3 billion tonnes per year and was generating solid wastes steams in the range of 10% to 40%. It is therefore evident that the building activities contribute significantly to the global ecological degradation and green house gas emissions. If we want to protect our future, there is no other options than to build in ways that not only reduce environmental damages but also improve the health of ecosystems and protect natural resources.

In the above context, one should note that as "ecology" is the study of relationship between organizations and environment, the "building ecology" refers to the study of the relationships between the act of building, the buildings and built forms that are produced, and the environment. It concerns our discovering the interconnections between buildings and nature and the effects of their interactions. On the whole, one may illustrate this discipline with the following subsets of knowledge:

a. **Knowledge of interdependency:** It covers the aspects that buildings, built environments and the process of building depend on nature for all their resources and that nature provides services like waste disposal and remediation that keep the living systems healthy.

b. **Knowledge of conservation and efficiency:** It refers to the basic principle that matter is neither created nor destroyed. It continually circulates through all living and non-living systems. Similarly energy cannot be created or destroyed. As we cannot ultimately create any more of many resources we require for building, we have to ensure that materials and energy are not wasted.

c. **Knowledge of surviving designs:** It is known that everything an engineer builds creates a system that continually needs the input of energy to keep it from breaking down. Engineers need to know the use of renewable forms of energy, efficient forms of energy, use of energy in a large number of small steps rather than in a small number of large steps, etc. In other words, the surviving design is based on the second and the fourth laws of thermodynamics.

d. **Knowledge of natural systems:** We have to be convinced that the life is sustained by the constant cycling of materials from the Earth, through plants and animals, to the atmosphere and back through the Earth. These cycles drive ecosystems and sustain a life-supporting biosphere. With this understanding engineers need to address the imbalances in biogeochemical flows caused by human activities including construction.

e. **Knowledge of change:** Engineers must know that the only certainty is that conditions always change. They need to understand that change is necessary for life to exist and that the ability to correctly perceive changes that are taking place is essential for adapting to new conditions. They have to learn that a sustainable building is not one that will last for ever but one that can easily adapt to change. They will have to apply their life-cycle thinking to create buildings that are resilient to environmental conditions and can cater to a diversity of human needs.

In conclusion, I may say that buildings are interdependent with nature over time. Relative to our own individual life-spans buildings as artifacts of human endeavour can last a very long time. From the day it is opened until well after those responsible for its creation are dead, a building's design, materials, energy requirements and its waste stream provides a built environment that people shape their lives within and around.

Hence in the context of "future", sustainability is a critical factor. For sustainability the green building concepts are essential and equally, if not more important is the training of engineers in the new discipline of "Building Ecology". The faster we appreciate this need, the better will be our preparedness for sustainability.

Special Lecture delivered by Dr. Gajanan M. Sabnis Emeritus Professor, Howard University, Washington, DC on "Sustainability and Green building"

Dr. Gajanan Sabnis, commenced his presentation with a brief history of sustainability and he specifically recalled the definition of sustainability adopted by the American Society of Civil Engineers in November, 1996. The definition adopted then, is as much valid today as it was then and is reproduced below:

"Sustainable development is the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development".

In the same breath, Dr. Sabnis also reminded the audience of the following definition of Green Buildings as given by the U. S. Green Building Council:

"Design and construction practices that significantly reduce, or eliminate the negative impact of buildings on the environment and its occupants with regard to site planning, safeguarding water use and water use efficiency, promoting energy efficiency and renewable energy, conserving materials and resources, and promoting indoor environmental quality".

In the above backdrop he reeled out some of the relevant statistics of the U.S. construction sector :

- 76 million residential buildings in the U.S.
- 5 million commercial buildings in the U.S.
- 40% raw materials consumption by this sector.
- 32% of the total energy produced goes to this sector.
- 17% fresh water is consumed by this sector.
- 25% global wood harvest is used up in the U.S.
- 5 billion gallons of water per day is used just for toilets.
- In terms of waste generation one may note : 25-40% of municipal solid wastes, 50% of the CFC production and 30% of the CO_2 production in the country.

In addition the building operations result in 49% of sulfur dioxide emission, 25% nitrous oxide emission and 10% of all particulate matters.

Dr. Sabnis emphasized that building green can be done for no additional cost. LEED buildings in the U.S. show only 2-3% cost increase on an average but it is believed that they can be done for the same budget as traditional buildings with proper planning. Savings from green buildings more than return any premium that one may choose to put into it. Design fees may be higher for Green Buildings but the construction costs can be reduced. In this context he reminded about Gandhian engineering which was targeted towards "getting more from less for more ". In other words, when the green buildings are made less expensive, many more people at the bottom of the pyramid will afford it and the societal benefits will accrue rather than making them expensive as a prerogative only for the top.

Concrete, he reinterated, is a green and durable product, if properly designed and used. The ready-mixed concrete plants should be a preferred mode for supply of concrete and he also gave an example of how a concrete home survived in a flood- devastated area in the U.S. (Fig. 1). Similarly, concrete houses saved lives in the case of fire (Fig. 2).

Fig 1: Survival of a Concrete Home in a flood-devastated area

Fig 2: Survival of a Concrete Home in a fire

A lot of useful steps should be taken at the design stage such as for the facade, the plan configuration, natural lighting, roof top section, etc. Water tanks/ catchment can be located on the roof top with a meter of water body, which acts as an insulator from the heat. Additional coating can be applied around the water area to reduce the glare and the surface temperature.

Use of Portland Pozzolana cement, recycling of water etc. should be duly considered. Dr. Sabnis also emphasized the importance of life cycle cost analysis (LCCA).

He illustrated the approach towards making a green house with the help of his own home in the U.S. which has the following important features:

1. Insulated concrete.
2. Recycled light-gauge steel.
3. Composite structure using concrete and steel.
4. Geothermal energy source.
5. Solar energy to complement the geothermal system.

An internal view of the hybrid construction is given in Fig. 3.

Fig 3: Staircase of composite steel and concrete

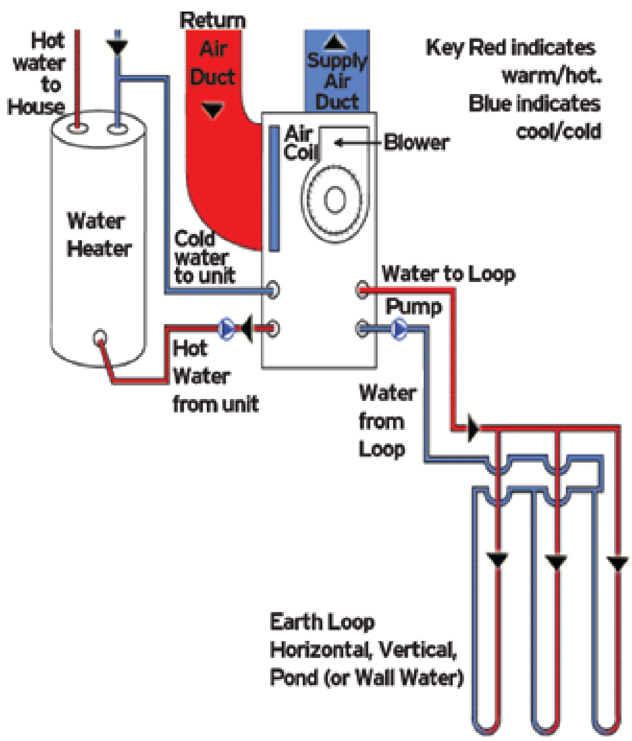

Fig 4: Geothermal heat pump installation system

The incorporation of geothermal heat pump (GHP) in the building was highlighted as a means of recycling the green energy. About a meter below the earth's surface, temperature remains relatively constant round the year (~15°C). A geothermal system, which consists of an indoor unit and a buried earth loop, capitalizes on this constant temperature. In the summer the system benefits from cooler temperature of the earth and carries it indoors. In the winter the process is reversed. Heat from the earth is carried indoors. The indoor unit compresses the heat to a higher temperature and enables space as well as water heating. This reservoir is available to any site, any locality, any country, at all times. A schematic circuit of the system is given in Fig. 4.

Other energy conservation measures included the use of low-E value windows, savings in utility bills, better sound insulation and external thermal insulation. Use of solar panels in the U.S. was also found to be economically viable with a payback period of 5 years and ROI of about 20%.

Finally, Dr. Sabnis put forth a case study of a sustainable city, providing the highest quality of life with the lowest environmental footprint having the following indices:

- 100% renewable energy
- zero waste
- zero carbon emission
- Fossil fuel free zone

He referred to the Masdar City initiative in Abu Dhabi in U.A.E. see (Fig. 5) It was indicated that the International Renewable Energy Agency (IRENA) established in Bonn on 26th January 2009 will share experiences on best practices and lessons in this project.

Fig 5: Masdar City Initiative

In conclusion, Dr. Sabnis mentioned about his book entitled "Green House: The Energy Efficient Home" and also about his next monograph on "Sustainability and Concrete" to be published later this year.

[Lecture was delivered on Healthy Construction Lecture series by Dr. Gajanan M. Sabnis, Emeritus Professor, Howard University, Washington, DC. at Bangalore and Mumbai on 4th and 5th June, 2010 respectively]

Go Green with Green Building Concept for a Sustainable Development

[Extracted from website www.igbc.in, www: wikipeia and www. bharatestates.com]

Green Building (Fig. 1), also known as green construction or sustainable building, is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from sitting to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability and comfort.

Fig 1: A Green Building

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation
- Natural deterioration

A similar concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural materials that are available locally. Other related topics include sustainable design, green architecture, and energy efficient buildings.

The green building movement originated due to need and desire for more energy efficient and environmentally friendly construction practices. There are a number of motives to building green, including environmental, economic, and social benefits. However, modern sustainability initiatives call for an integrated and synergistic design to both new construction and in the retrofitting of an existing structure. Also known as sustainable design, this approach integrates the building life-cycle with each green practice employed with a design-purpose to create a synergy amongst the practices used.

Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off. Many other techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well.

While the practices, or technologies, employed in green building are constantly evolving and may differ from region to region, there are fundamental principles that persist from which the method is derived: Sitting and Structure Design Efficiency, Energy Efficiency, Water Efficiency, Materials Efficiency, Indoor Environmental Quality Enhancement, Operations and Maintenance Optimization, and Waste and Toxics Reduction. The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect.

On the aesthetic side of green architecture or sustainable design is the philosophy of designing a building that is in harmony with the natural features and resources surrounding the site. There are several key steps in designing sustainable buildings: specify 'green' building materials from local sources, reduce loads, optimize systems, and generate on-site renewable energy.

Siting and Structure Design Efficiency

The foundation of any construction project is rooted in the concept and design stages. The concept stage, in fact, is one of the major steps in a project life cycle, as it has the largest impact on cost and performance. In designing environmentally optimal buildings, the objective function aims at minimizing the total environmental impact associated with all life-cycle stages of the building project. However, building as a process is not as streamlined as an industrial process, and varies from one building to the other, never repeating itself identically. In addition, buildings are much more complex products, composed of a multitude of materials and components each constituting various design variables to be decided at the design stage. A variation of every design variable may affect the environment during all the building's relevant life-cycle stages.

Creating sustainable buildings starts with proper site selection. The location of a building affects a wide range of environmental factors such as security, accessibility, and energy consumption, as well as the energy consumed by transportation needs of occupants for commuting, the impact on local ecosystems, and the use/reuse of existing structures and infrastructures. If possible, locating buildings in areas of existing development where infrastructure already exists and conserving resources by renovating existing buildings will help minimize project's environmental footprint.

Maximizing the green impact of site design and building infrastructure may be accomplished by considering energy implications during site selection and the design of building orientation. Improved grading and natural landscaping practices can help control erosion as well as reduce heat islands. Incorporating transportation solutions along with site plans that acknowledge the need for bicycle parking, car pool staging, and proximity to mass transit can help encourage alternatives to traditional commuting and reduce both energy consumption and waste emissions.

Energy Efficiency

Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope, (the barrier between conditioned and unconditioned space), they may use high-efficiency windows and insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy loads.

On site generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building. Power generation is generally the most expensive feature to add to a building.

Fig. 2: Measurement of temperature difference between Energy Efficient Heatshield coated and uncoated surfaces

Some of the other facets of green buildings are: heat reduction insulated roofs (Fig. 2) and walls that substantially reduce heat ingress (up to 60%) thereby resulting in lower AC loads, cross ventilation with fresh breeze, goodbye to high energy costs (up to 40%), solar lighting is safe for people as well as the planet, 100% natural light all across, thereby cutting down usage of artificial light by 50%.

Water Efficiency

Reducing water consumption and protecting water quality are key objectives in sustainable building. One critical issue of water consumption is that in many areas of the country, the demands on the supplying aquifer exceed its ability to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site. The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing. Waste-water may be minimized by utilizing water conserving fixtures such as water less urinal (Fig. 3), ultra-low flush toilets and low-flow shower heads (Fig. 4). Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation.

Fig. 3: Waterless urinals

Fig. 4: Low-flow shower head

Materials Efficiency

Building materials typically considered to be 'green' include rapidly renewable plant materials like bamboo (because bamboo grows quickly) and straw, lumber from forests certified to be sustainably managed, ecology blocks, dimension stone, recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable (e.g. Trass, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, seagrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone, concrete (high and ultra high performance, self-healing concrete, etc.) The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, foundry sand, and demolition debris in construction projects.

Polyurethane heavily reduces carbon emissions as well. Polyurethane blocks are being used for walls which provide more speed, less cost, and they are environmentally friendly. Light weight energy saving sandwich panel is also used for wall for heat reducing (Fig. 5). Building materials should be extracted and manufactured locally to the building site to minimize the energy embedded in their transportation. Where possible, building elements should be manufactured off-site and delivered to site, to maximise benefits of off-site manufacture including minimising waste, maximising recycling (because manufacture is in one location), high quality elements, less noise and dust.

Fig. 5: Energy saving sandwich panel

Indoor Environmental Quality Enhancement

The Indoor Environmental Quality (IEQ) category in LEED (Leadership in Energy and Environmental Design) standards, one of the five environmental categories, was created to provide comfort, well-being, and productivity of occupants. The LEED IEQ category addresses design and construction guidelines especially indoor air quality (IAQ), thermal quality, and lighting quality. Indoor Air Quality seeks to reduce volatile organic compounds, or VOC's, such as microbial contaminants. Buildings rely on a properly designed HVAC (High Volume Air Conditioning) system to provide adequate ventilation and air filtration as well as isolate operations (kitchens, dry cleaners, etc.) from other occupancies. During the design and construction process choosing construction materials and interior finish products such as antimicrobial coating (Fig. 6) with zero or low emissions will improve IAQ. Many building materials and cleaning/maintenance products emit toxic gases, such as VOC's and formaldehyde. These gases can have a detrimental impact on occupants' health and productivity as well. Avoiding these products will increase a building's IEQ. The temperature and airflow control over the HVAC system coupled with a properly designed building envelope will also aid in increasing a building's thermal quality. Creating a high performance luminous environment through the careful integration of natural and artificial light sources will improve on the lighting quality of a structure.

Healthy indoors: One can enjoy healthy living with innovative solid waste management, waste segregation system and nature-friendly infrastructural facilities.

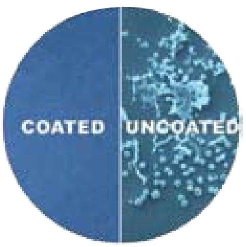

Fig. 6: Hygiene coating

Recycling to conserve nature: Owners can take pride in being a responsible citizen and make the most of '0% discharge building.

Operations and Maintenance Optimization

No matter how sustainable a building may have been in its design and construction, it can only remain so if it is operated responsibly and maintained properly. Ensuring operations and maintenance (O&M) personnel are part of the project's planning and development process will help retain the green criteria designed at the onset of the project. Every aspect of green building is integrated into the O&M phase of a building's life. The addition of new green technologies also falls on the O&M staff. Although the goal of waste reduction may be applied during the design, construction and demolition phases of a building's life-cycle, it is in the O&M phase that green practices such as recycling and air quality enhancement take place.

Waste Reduction

Green architecture also seeks to reduce waste of energy, water and materials used during construction. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills.

To reduce the impact on wells or water treatment plants, several options exist. 'Greywater', waste water from sources such as dish washing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, e.g. to flush toilets and wash cars (Fig. 7). Rainwater collectors are used for similar purposes.

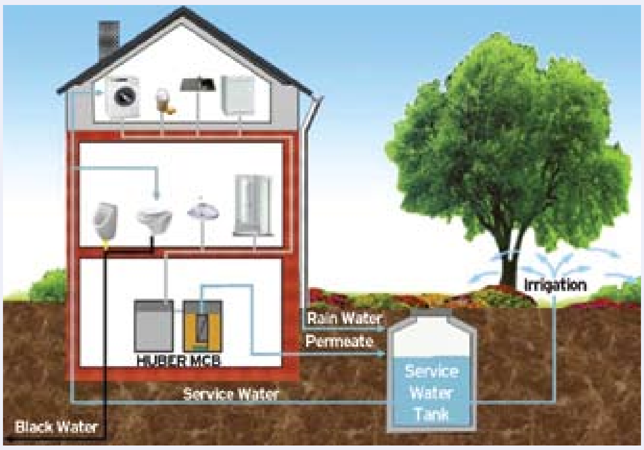

Fig. 7: Grey water recycling system

Centralized waste water treatment systems can be costly and use a lot of energy. An alternative to this process is converting waste and waste water into fertilizer, which avoids these costs and shows other benefits. By collecting human waste at the source and running it to a semi-centralized bio gas plant with other biological waste, liquid fertilizer can be produced. Practices like these provide soil with organic nutrients and create carbon sinks that remove carbon dioxide from the atmosphere, offsetting greenhouse gas emission. Producing artificial fertilizer is also more costly in energy than this process.

Indian Green Building Council

Indian Green Building Council (IGBC) is a part of CII(Confederation of Indian Industry) and Federation of Indian Chambers of Commerce and Industry (FICCI)which is actively involved in promoting the Green Building movement in India. The council is represented by all stakeholders of construction industry comprising of corporate, government & nodal agencies, architects, product manufacturers, institutions, etc. The council is industry-led, consensus-based and member-driven. The vision of the council is to serve as single point solution provider and be a key engine to facilitate all Green Building activities in India.

The Indian Green Business Centre in Hyderabad is the first platinum rated building to be built outside of the USA and an example of an institution created by an industry association. CII jointly with the Andhra Pradesh government and with technical support from USAID (United States Aids for International Development) set it up as a public-private partnership.

IGBC Green Homes Rating System

Indian Green Building Council (IGBC) Green Homes is the first rating programme developed in India, exclusively for the residential sector. It is based on accepted energy and environmental principles and strikes a balance between known established practices and emerging concepts. The system is designed to be comprehensive in scope, yet simple in operation.

To bridge the demand for a rating system for non-air conditioned buildings and one that took into account the possibility of a partially air conditioned building as well, TERI (The Energy and Resources Institute) developed its own system known as GRIHA (Green Rating for Integrated Habitat Assessment). This system responded specifically to India's prioritized national concerns such as extreme resource crunches in the Power and water sectors and a fast eroding biodiversity. It attempted to stress on solar passive techniques for optimizing indoor visual and thermal comfort and relying on refrigeration based air-conditioning systems only in cases of extreme discomfort. However, this system has only been developed for the largest upcoming energy consuming segment, i.e. commercial, institutional and residential buildings (new construction), and is in the course of developing a similar standard to address the needs of other building typologies such as existing buildings, industrial buildings, etc.

Now, in consultation with the experts from various related fields in India, the MN&RE (Ministry of Natural Resources & Renewable Energy) is planning developing a national rating system for green buildings. This shall be a voluntary system to be adopted by builders and individuals alike. The MN&RE is trying to develop an incentive mechanism for the same as well.

Benefits of Green Homes

A Green Home can have tremendous benefits, both tangible and intangible. The immediate and most tangible benefit is in the reduction in water and operating energy costs right from day one, during the entire life cycle of the building.

Tangible benefits include energy savings between 20 – 30% and water savings between 30 – 50% where as intangible benefits include enhanced air quality, excellent day lighting, health & wellbeing of the occupants, conservation of scarce national resources, and enhance marketability for the project.

Eligibility

IGBC Green Homes Rating System is a measurement system designed for rating new residential buildings which include construction categories such as individual homes, high rise residential apartments, gated communities, row houses, and existing residential buildings which retrofit and redesigned in accordance with the IGBC Green Homes criteria.

The project team can evaluate all the possible points to apply under the rating system using a suitable checklist. The project can apply for IGBC Green Homes certification if it can meet all mandatory requirements and achieve the minimum required points.

IGBC Green Factory Building rating system

With the advancement of green building movement in India, many companies have evinced keen interest in having a holistic green design and construction framework for upcoming factory buildings. IGBC, in its endeavor to extend green building concepts to all building types has developed the IGBC Green Factory Building rating system. IGBC Green Factory Building rating system is the first of its kind addressing sustainability in industrial buildings. The programme is fundamentally designed to address national priorities and quality of life for factory workmen.

IGBC Green Factory Building Rating System is a voluntary and consensus based programme. The rating system has been developed based on the contemporary materials and technologies. This rating system would facilitate the development of green factories. The rating system evaluates certain credit points using a prescriptive approach and other credits on a performance based approach. The rating system is evolved so as to be comprehensive and at the same time user-friendly.

LEED India

In the year 2001, The US-GBC's internationally accepted and renowned rating system – LEED was introduced in the Indian building sector. Thereafter LEED-INDIA Green Building Rating System has become a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings.

LEED-INDIA provides building owners, architects, consultants, developers, facility managers and project managers the tools they need to design, construct and operate green buildings. It promotes a whole-building approach to sustainability by recognizing performance in the following five key areas such as Sustainable site development, Water savings, Energy efficiency, Materials selection and, Indoor environmental quality.Its' rating system provides a roadmap for measuring and documenting success for every building type and phase of a building lifecycle. Specific LEED-INDIA programs include for New Construction (LEED India NC) and for Core and Shell (LEED India CS).

Green Building Materials

The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. The use of green building materials and products represents one important strategy in the design of a building.

Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40% of total global use. Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

Typical Products and equipment are Roof paints, Variable frequency drives, High efficiency chillers, BMS, Efficient lighting etc. According to IGBC, after the introduction of the LEED rating system in India, several new energy efficient equipments have been introduced in the country and are being produced locally. It would be accurate to say the introduction of the system has stimulated some innovation within the building materials supply industry. To name a few – High albedo roofing materials, High performance glass, waterless urinals, Fly ash bricks for walls, Roof insulation Materials, High COP (Coefficient of Performance) chillers. Besides this, a market has been created to offer energy simulation services.

Three basic steps of product selection

Product selection can begin after the establishment of project-specific environmental goals. The environmental assessment process for building products involves three basic steps such as research, evaluation and selection.

Research: This step involves gathering all technical information to be evaluated, including manufacturers' information such as Material Safety Data Sheets (MSDS), Indoor Air Quality (IAQ) test data, product warranties, source material characteristics, recycled content data, environmental statements, and durability information. In addition, this step may involve researching other environmental issues, building codes, government regulations, building industry articles, model green building product specifications, and other sources of product data. Research helps identify the full range of the project's building material options.

Evaluation: This step involves confirmation of the technical information, as well as filling in information gaps. For example, the evaluator may request product certifications from manufacturers to help sort out possible exaggerated environmental product claims. Evaluation and assessment is relatively simple when comparing similar types of building materials using the environmental criteria, e.g., a recycled content assessment between various manufacturers of medium density fiberboard is a relatively straightforward "apples to apples" comparison. However, the evaluation process is more complex when comparing different products with the same function. Then it may become necessary to process both descriptive and quantitative forms of data.

A life cycle assessment (LCA) is an evaluation of the relative "greenness" of building materials and products. LCA addresses the impacts of a product through all of its life stages. Although rather simple in principle, this approach has been difficult and expensive in actual practice (although that appears to be changing).

Selection: This step often involves the use of an evaluation matrix for scoring the project-specific environmental criteria. The total score of each product evaluation will indicate the product with the highest environmental attributes. Individual criteria included in the rating system can be weighted to accommodate project–specific goals and objectives.

Conclusion

'Green Building' technology is a futuristic idea for the planet and is pro life. It is inspired from various elements of nature and innovatively designed to generate significant economic and health advantages to us. It takes us closer to nature by bringing nature closer to home. In fact, it makes the whole growth story of mankind sustainable.

System and Criteria for Rating of a Green Building in India

[Extracted from "TERI-GRIHA (TERI-Green Rating for Integrated Habitat Assessment)" pp. 2 – 13 from the website: http://www.hareda.gov.in/TERI.PDF]

1.0 Introduction

The green building rating system devised by TERI is a voluntary scheme. It has derived useful inputs from the upcoming mandatory building codes/guidelines being developed by the Bureau of Energy Efficiency, the Ministry of Non-Conventional Energy Sources, MoEF (Ministry of Environment and Forests), Government of India, and the Bureau of Indian Standards. The rating system aims to achieve efficient resource utilisation, enhanced resource efficiency, and better quality of life in buildings.

1.1 The benefits

TERI's green building rating will evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system , based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period. On a broader scale, this system, along with the activities and processes that lead up to it, will benefit the community at large with the improvement in the environment by reducing GHG (greenhouse gas) emissions, improving energy security, and reducing the stress on natural resources. Some of the benefits of a green design to a building owner, user, and the society as a whole are as follows:

- Reduced energy consumption without sacrificing the comfort levels
- Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil
- loss from erosion, etc.
- Reduced air and water pollution (with direct health benefits)
- Reduced water consumption
- Limited waste generation due to recycling and reuse
- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketability

1.2 The basic features

Currently the system has been developed to help 'design and evaluate' new buildings (buildings that are still at the inception stages). A building is assessed based on its predicted performance over its entire life cycle –inception through operation. The stages of the life cycle that have been identified for evaluation are the preconstruction, building design and construction, and building operation and maintenance stages. The issues that get addressed in these stages are as follows:

- Pre-construction stage (intra- and inter-site issues)
- Building planning and construction stages (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well being). The prime resources that are considered in this section are land, water, energy, air, and green cover.
- Building operation and maintenance stage (issues of operation and maintenance of building systems and processes, monitoring and recording of consumption, and occupant health and well being, and also issues that affect the global and local environment).

1.3 How to get your building rated?

All buildings, except for industrial complexes and housing colonies, which are in the design stage, are eligible for certification under the TERI system. Buildings include offices, retail spaces, institutional buildings, hotels, hospital buildings, healthcare facilities, residences, and multi-family high-rise buildings. The detail guidelines are available in the above mentioned website of TERI-GRIHA.

1.4 Criteria for rating Green Building

1.4.1 Site planning

Conservation and efficient utilization of resources

Objective: To maximize the conservation and utilisation of resources (land, water, natural habitat, avi fauna, and energy) conservation and enhance efficiency of the systems and operations.

Criterion 1 Preserve and protect the landscape during construction/compensatory depository forestation.
Commitment: Proper timing of construction, preserve top soil and existing vegetation, staging and spill prevention, and erosion and sedimentation control. Replant, on-site, trees in the ratio 1:3 to those removed during construction.

Criterion 2 Soil conservation (till post-construction).
Commitment: Proper top soil laying and stabilization of the soil and maintenance of adequate fertility of the soil to support vegetative growth.

Criterion 3 Design to include existing site features.
Commitment: Minimize the disruption of natural ecosystem and design to harness maximum benefits of the prevailing micro-climate.

Criterion 4 Reduce hard paving on-site and /or provide shaded hard-paved surfaces.
Commitment: Minimize storm water run-off from site by reducing hard paving on site.

Criterion 5 Enhance outdoor lighting system efficiency.
Commitment: Meet minimum allowable luminous efficacy (as per lamp type) and make progressive use of a renewable energy-based lighting system.

Criterion 6 Plan utilities efficiently and optimize on-site circulation efficiency.
Commitment: Minimize road and pedestrian walkway length by appropriate planning and provide aggregate corridors for utility lines.

Health and well being

Objectives: To protect the health of construction workers and prevent pollution.

Criterion 7 Provide at least, the minimum level of sanitation/ safety facilities for construction workers.
Commitment: Ensure cleanliness of workplace with regard to the disposal of waste and effluent, provide clean drinking water and latrines and urinals as per applicable standard.

Criterion 8 Reduce air pollution during construction.
Commitment: Ensure proper screening, covering stockpiles, covering brick and loads of dusty materials, wheel-washing facility, water spraying.

1.4.2 Building planning and construction stage

Conservation and efficient utilization of resources

Objective: To maximize resource (water, energy, and materials) conservation and enhance efficiency of the system and operations.

Criterion 9 Reduce landscape water requirement.
Commitment: Landscape using native species and reduce lawn areas while enhancing the irrigation efficiency, reduction in water requirement for landscaping purposes.

Criterion 10 Reduce building water use.
Commi tment: Reduce building water use by applying low-flow fixtures, etc.

Criterion 11 Efficient water use during construction.
Commitment: Use materials such as pre-mixed concrete for preventing loss during mixing. Use recycled treated water and control the waste of curing water.

Energy: end use

Criterion 12 Optimise building design to reduce the conventional energy demand.
Commitment: Plan appropriately to reflect climate responsiveness, adopt an adequate comfort range, less air-conditioned areas, day lighting, avoid over-design of the lighting and air conditioning systems.

Criterion 13 Optimise the energy performance of the building within specified comfort limits.
Commitment: Ensure that energy consumption in building under a specified category is 10%-40% less than that benchmarked through a simulation exercise.

Energy: embodied and construction

Criterion 14 Utilization of fly ash in the building structure.
Commitment: Use of fly ash for RCC (reinforced cement concrete) structures with in-fill walls and load bearing structures, mortar, and binders.

Criterion 15 Reduce volume, weight, and time of construction by adopting an efficient technology (e.g. pre-cast systems, ready -mix concrete, etc.).
Commitment: Replace a part of the energy -intensive materials with less energy intensive materials and/ or utilize regionally available materials, which use low energy/ energy-efficient technologies.

Criterion 16 Use low-energy material in the interiors.
Commitment: Minimum 70% in each of the three categories of interiors (internal partitions, paneling/false ceiling/interior wood finishes/ in-built furniture door/ window frames, flooring) from low-energy materials/ finishes to minimize the usage of wood.

Energy: renewable

Criterion 17 Renewable energy utilization.
Commitment: Meet energy requirements for a minimum of 10% of the internal lighting load (for general lighting) or its equivalent from renewable energy sources

(solar, wind, biomass, fuel cells, etc). Energy requirements will be calculated based on realistic assumptions which will be subject to verification during appraisal.

Criterion 18 Renewable energy - based hot - water system.
Commitment: Meet 70% or more of the annual energy required for heating water through renewable energy based water-heating systems.

Recycle, recharge, and reuse of water

Objective: To promote the recycle and reuse of water.

Criterion 19 Waste- water treatment
Commitment: Provide necessary treatment of water for achieving the desired concentration of effluents.

Criterion 20 Water recycle and reuse (including rainwater).
Commitment: Provide wastewater treatment on-site for achieving prescribed concentration, rainwater

harvesting, reuse of treated waste water and rainwater for meeting the building's water and irrigation demand.

Waste management

Objective: To minimize waste generation, streamline waste segregation, storage, and disposal, and promote resource recovery from waste.

Criterion 21 Reduction in waste during construction.
Commitment: Ensure maximum resource recovery and safe disposal of wastes generated during construction and reduce the burden on landfill.

Criterion 22 Efficient waste segregation.
Commitment: Use different coloured bins for collecting different categories of waste from the building.

Criterion 23 Storage and disposal of waste.
Commitment: Allocate separate space for the collected waste before transferring it to the recycling/disposal stations.

Criterion 24 Resource recovery from waste.
Commitment: Employ resource recovery systems for biodegradable waste as per the

Solid Waste Management and handling Rules, 2000 of the MoEF. Make arrangements for recycling of waste through local dealers

Health and well-being

Objective: To ensure healthy indoor air quality, water quality, and noise levels, and reduce the global warming potential.

Criterion 25 Use of low-VOC (volatile organic compounds) paints/ adhesives / sealants.
Commitment: Use only low VOC paints in the interior of the building. Use water – based rather than solvent based sealants and adhesives.

Criterion 26 Minimize ozone depleting substances.
Commitment: Employ 100% zero ODP (ozone depletion potential) insulation; HCFC (hydrochloro fluorocarbon)/ and CFC (chlorofluoro carbon) free HVAC and refrigeration equipments and/halon-free fire suppression and fire extinguishing systems.

Criterion 27 Ensure water quality.
Commitment: Ensure ground water and municipal water meet the water quality norms as prescribed in the Indian Standards for various applications (Indian Standards for drinking [IS 10500-1991], irrigation applications [IS 11624-1986]. In case the water quality cannot be ensured, provide necessary treatment of raw water for achieving the desired concentration for various applications.

Criterion 28 Acceptable outdoor and indoor noise levels.
Commitment: Ensure outdoor noise level conforms to the Central Pollution Control Board–Environmental Standards–Noise (ambient standards) and indoor noise level conforms to the National Building Code of India, 2005, Bureau of Indian Standards,

Part 8–Building Services; Section 4–Acoustics, sound insulation, and noise control.

Criterion 29 Tobacco and smoke control.
Zero exposure to tobacco smoke for non-smokers, and exclusive ventilation for smoking rooms.

1.4.3 Building operation and maintenance

Objective: Validate and maintain 'green' performance levels/adopt and propagate green practices and concepts.

Criterion 30 Energy audit and validation.
Commitment: Energy audit report to be prepared by approved auditors of the Bureau of Energy Efficiency, Government of India.

Criterion 31 Operation and maintenance protocol for electrical and mechanical equipment.
Commitment: Ensure the inclusion of a specific clause in the contract document for the commissioning of all electrical and mechanical systems to be maintained by the owner, supplier, or operator. Provide a core facility/ service management group, if applicable, which will be responsible for the operation and maintenance of the building and the electrical and mechanical systems after the commissioning. Owner/builder/occupants/service or facility management group to prepare a fully documented operations and maintenance manual, CD, multimedia or an information brochure listing the best practices/do's and don'ts/maintenance requirements for the building and the electrical and mechanical systems along with the names and addresses of the manufacturers/suppliers of the respective system.

Criterion 32 Bonus points.

Four bonus points are available under the rating system for adopting criteria which enhance the green intent of a project, and the applicant can apply for the bonus points. Some of the probable points, not restricted to the ones enumerated below, could be alternative transportation, Environmental education, company policy on green supply chain, life cycle cost analysis and any other criteria proposed by applicant.

The above ratings have been customized in Indian context but there is every scope for further betterment than these criterions as specified.

A Preliminary Assessment of Building Codes/Standards in India for Energy Conservation Buildings

[Excerpts from the article "India: The Way Towards Energy and Resource Efficient Buildings" from the website http://www.asiabusinesscouncil.org/docs/BEE/papers/BEE_Policy_India.pdf]

1.0 Introduction

India has many central and local authorities and bodies that help compile building codes and standards that are applicable at local and national levels. As of now, there are different codes that have been developed by bodies such as:

- The Bureau of Indian Standards – National Building Code (NBC), 2005
- The Bureau of Energy Efficiency(BEE)–Energy Conservation Building Code (ECBC), 2009
- Ministry of Environment and Forests – Environmental Impact Assessment and clearance.

The code which as most significant impact on energy efficiency in buildings is the ECBC, has a prescriptive and performance based part. The prescriptive route calls for adoption of minimum standards and efficiencies for building envelope and systems (lighting, HVAC, service water heating and electrical). The performance based approach requires whole building simulation approach to prove efficiency over base building as defined by the code. This leaves the code inherently flexible and easy to adopt.

To ensure the success of the Code and its adoption we need to ensure that activities such as strengthening of institutional frameworks, inter-departmental linkages, capacity building of Urban Local Bodies are undertaken urgently.

1.1 Assessment and apprehension

The national building code and ECBC should be integrated. This would lead to uniformity and larger adoption of energy code (as NBC is mostly adopted by State governments in their building byelaws).

1. Most of the large developers are still unaware of ECBC.
2. Large-scale availability of appropriate materials and equipment to meet requirement of ECBC is urgently needed. The Energy codes are relatively new in India and the products (insulation, efficient glass, efficient HVAC systems etc) and services required by buildings to comply with the code requirements are not readily and abundantly available.
3. The architects who are aware of the ECBC are very apprehensive of increased initial cost vis-à-vis life cycle cost of some high cost measures recommended by the code e.g. insulation (which is still largely imported and the technical expertise for installation is with a handful of companies) and efficient glazing (low 'U' glass for windows is increasing in demand in India but the supply is largely met via imports). This leads to increased initial costs varying between 10% to 40% depending on the technologies/materials/equipments adopted and the skill set (technical and labor related) required to deliver the same.
4. There is lack of knowledge among designers to analyze designs based on code requirements due to the novelty of the concept of energy efficiency. This is because the whole concept of a building code is new. Energy simulation capability to quantify savings based on energy efficiency parameters as defined by the code is very limited. The building construction industry (contractors, services providers) is not geared to apply these measures practically on site.
5. The energy conservation act empowers the state government to amend the energy conservation building codes to suit the regional and local climatic conditions. This provision may in longer run lead to large deviations from the ECBC that has been developed by the BEE. This may lead to confusion among builders/developers /designers.
6. As initial boost on promotion of energy efficient products and services is required in form of import duty relaxation, reduced tax, excise duty. The government could play a major role in realizing the same. There is no concrete plan for implementation of the code, or monitoring and verification.
7. The BEE has introduced the code on a voluntary level and slowly make it mandatory with adequate data to justify the benefits of doing so. The code may be made mandatory in larger cities logically where the savings potential is significant in comparison to smaller towns followed by smaller ones.
8. The builders and developers who have to get environmental clearance from the Ministry of Environment and Forests feel that it leads to additional delays as the clearance process is very time and resource consuming. Also due to absence of normative guidelines for the same they are often left unsure of the options that they have to adopt in their projects to make the projects environmentally sensitive

2.0 Appliance labeling and standard

Due to a multiplicity of manufacturers of electrical equipment all over the country, there is significant variation in the energy consumption and resultantly efficiency of household electrical equipment. To make the situation worse, information pertaining to a piece of equipment's energy consumption is either not known or difficult to understand. The Bureau of Energy Efficiency's standards and labeling (S&L) program aims to ensure the availability of only energy efficient equipment and appliances to the people.

Initially, the program shall aim to help the people in taking informed decisions towards purchasing an appliance based on its energy consumption and efficiency. This will help to identify appliances that perform poorly with respect to energy consumption. After the initial stage, the program shall help establish a minimum energy performance standard to ensure that all the appliances available to the purchasers necessarily conform to a prescribed standard. This will provide the necessary pull in the market to enable the transition from the current. The first few equipment and appliances that have been short-listed for the program are as follows:

- Refrigerators with or without a low temperature compartment
- Room air conditioners (unitary)
- Stationary storage type electric water heaters
- Electric motors up to 100kW
- Agricultural pump sets up to 10kW
- Fluorescent tube lights
- Ballasts
- Compact Fluorescent lamps
- Distribution Transformers
- Industrial Fans and Blowers up to 100kW
- Air compressors up to 100 kw

2.1 Financial / fiscal incentives

Energy efficiency is still not largely incentivized in India. However, there are several incentives offered of renewable energy technologies by the central as well as some progressive state governments. The various kind of incentives are made available under the Ministry of New and Renewable Energy Sources' schemes.

3.0 Implementation of building energy efficiency policies in India

3.1 Need of an effective management system/ implementation infrastructure for new buildings and for upgrades in existing buildings

As mentioned in the sections above, there is no integrated framework for management and implementation of energy efficiency. India is still in very early stages of energy code implementation. There is a strong need felt for an institutional framework with well-defined authority and responsibility. The capacity of the state level bodies, which would be responsible for the final adaptation and implementation of the energy code, should be strengthened. There is need to develop to a set of code official who would understand the energy code thoroughly along with its enforcement requirements.

Demonstration projects are required at key geographical locations of the country to test the effectiveness code recommendations on real time projects. TERI GRIHA has adopted the ECBC within its framework and thus promises to deliver buildings in conformance to the ECBC. In addition to new buildings, there is also a large chunk of existing buildings that need overhauling from an energy efficiency point of view. The BEE has started mandate energy auditing for all commercial buildings above a certain threshold of connected load and has developed mechanisms to ensure that the recommendations of the audit are implemented in a stipulated time.

3.2 BEE energy rating certification

All buildings or building complexes with connected load of 100KW and above are considered and their energy performance index is being calculated. This is being derived from a formula of kilowatt per hour/per square meter/per year consumption of power. The data which are required to calculate energy performance index are built up area, conditioned and non-conditioned area, type of building, types of energy saving measures for various equipment and climatic zone in which building is located. Those showing index below 100 are given five-star rating indicating the most efficient. The rating ranges from one star to five star, based on energy conservation method adopted by the installations and the quantum of energy saved per year. Initially the programme is targeted for three climatic zones-warm and humid, composite and hot and dry for air-conditioned and non-air-conditioned office buildings which will be followed by other two climatic zones and night-duty offices. However this rating should be started immediately for other segments like industries and housing societies and thereafter for hotels, hospitals, retail malls, and IT parks. So far 49 of buildings in India are eligible for energy-saving status and another 62 are to be included very soon in this list. Mumbai has maximum 10 nos. of energy saving buildings and Cement House (ACC) on Maharshi Karve road (Fig. 1) is the only five star rating building. New Delhi has eight nos. of rated building followed by four in Hyderabad and three each in Pune, Ahmedabad, Jaipur and two in Chennai and one each in Cochin, Ambala Cantt, Bhopal, Bhubaneswar, Kanpur, Thirivanthapuram, Lucknow, Tiruchirapalli.

3.3 Barriers for owners/developers to implement energy efficient measures

There has been general lack of interest among builders to implement energy efficiency in their buildings because of the sheer dichotomy of the fact that "he who invests does not reap benefits of the investment". According to some leading builders in India the following are the main deterrents:

Fig. 1: Cement House (ACC) on Maharshi Karve road, Mumbai

There are planning constrains on the site, the individual plots are pre allocated by the state development authorities. Therefore, passive features like right orientation are difficult to achieve. The builders are not ready to sacrifice on maximum optimization of the space and design in order to adopt energy efficiency features in the building design.

- In a colony developed by the builders, he only constructs 5-10%. Rest of the land is sold to different buyers and stakeholders in the market, and thus has no control on the energy efficiency of those buildings. In a colony the builder just builds public buildings, community halls, where they could implement the energy efficiency measures.
- Increase in initial building cost restricts the builders from not adopting energy efficiency measures in their buildings. The builders mostly look at the project from commercial aspects rather than from its efficiency aspect. Moreover the customer being mostly unaware of its advantages does not demand energy efficiency.
- Unavailability of efficient equipments in India is another major barrier. Equipment imported from abroad example from China, increases the cost of the equipment and also results into more time consumption for installation, which delays the project.
- No incentives from the government. There should be tax rebate or duty rebates from the government to the developer; otherwise the developer has no reason to invest more capital in making the buildings energy efficient.
- Back up industry in terms of materials, equipments and technical expertise is not coming up as fast as the construction industry.
- Lack of infrastructure to provide power and gas from the state government forces the developer to invest in 100% power backup. If the state provides reliable power supply, this chunk of money could be shifted to incorporate energy efficiency measures in the buildings.

4.0 Local Level Implementation Successful cases

4.1 Initiative of local Municipal Corporation of Thane (TMC), Maharashtra

The municipal corporation of Thane, covering an area of 147 sq. km and population of nearly 1.7 million is one of the most progressive municipal corporations located in western India. The municipality has taken consistent actions over past years and has demonstrated energy savings by application of no-cost and cost effective energy conservation techniques. TMC has an energy conservation cell responsible for identifying energy conservation opportunities and implement projects to effect savings. TMC has been able to make a savings of ₹ 32 million during last 3 financial years. The basic approach followed to ensure maximum outreach and benefits out of their efforts are:

1. Large-scale awareness generation among own employees and residents of the municipality. The awareness generation stresses use of no cost or low cost options. For e.g., avoid wastages by switching of gadgets when not required.
2. Implement cost effective energy saving measures in municipal services and public buildings e.g. 33% energy saving was achieved in street lighting through introduction of energy efficient lamps and ballasts, municipal water pumping efficiency was enhanced through suitable retrofits.
3. Waste to energy projects have been commissioned with private participation.
4. TMC is also taking innovative initiatives and has started implementing solar energy based A.C. systems for few public buildings and also encouraging the builders to implement it. TMC has also modified the development control rule (building bye law) to mandate use of solar water heating system(SWH) (Fig. 2) in certain building typologies. In order to promote use of SWH, TMC also offer property tax incentives to residential users. Having realized that implementation of most of the projects based on non-conventional power sources do not offer attractive returns instantly, TMC is exploring CDM (Clean Development Mechanism) route and availing benefits there from. This can genertate opportunities for carbon credit trading in the international market and help avail the financial benefits accrued from that, not to mention the mitigation of Green House Gases released into the atmosphere due to use of conventional technologies. TMC is one of the most revered municipalities in the country, which has also

received several state level and national awards for in energy conservation activities.

Fig. 2: Solar water heater

4.2 Initiative by a private developer in Bangalore, T-ZED homes

T-ZED homes have been promoted by one of India's largest 'sustainably built environment' [SBE] enterprise, BCIL Builders, Bangalore. A cluster of 95 homes built over an area of 5 acres in the city of Bangalore, these homes aims to set new standards for residential housing. The basic features and highlights of the complex are:

- Energy efficient homes built using materials and technologies that have low embodie energy.
- Ergonomically designed.
- These homes come with built-in energy efficient lights, solar hybrid fans in each of the washrooms, intelligently switched lighting systems for corridors and other areas, master controller operable through mobile, offsite green power generation using is a biomass gasifier that uses wood chip as fuel, grown or procured in a sustainable way, customized environment-friendly (brine-based), zero electricity refrigerator cum freezer and home air-conditioning that is fully controlled, and is based 100 per cent on fresh air .
- The campus also have a 24-hour DG backup made up of two 125 KVA genset modules that will be powered by bio-diesel.
- Extensive water conservation measures coupled with rain water harvesting and reuse
- These homes do not cost higher than conventional homes and yet promises attractive returns on investment through power and water savings
- These home owners have been involved in the entire design and construction process and have made valuable additions to the design.
- The project is considering applying for carbon credits under CDM.
- The project demonstrates that it is possible to deliver sustainable homes at no added costs with help of a dedicated team of intelligent professionals and a well-informed Clientele.

5.0 Recommendations

There are several cross-cutting issues that need to be addressed holistically in order to ensure energy efficiency in building. The current policy framework does not support the same. For example, enforcement of energy conservation building codes under the purview of Ministry of Power and designated state nodal agencies, while sanctioning power for building plans rests with local development authority or municipal corporations. There is no worked out modality for integration of energy conservation building code with local building bye-laws. The energy conservation act empowers the state government to amend the energy conservation building codes to suit the regional and local climatic conditions. This provision may in longer run lead to large deviations from the ECBC that has been developed by the BEE. The renewable energy programs and incentives are not integrated with policies and programs of the Ministry of Power. To promote energy efficiency and conservation, we need to create an appropriate set of incentives through pricing and other policy measures.

List of some of the building energy codes/standards/ policies programs in India and their websites

Energy Efficiency Plan/Policy:

The Electricity Act of 2003:

http://www.beeindia
http://powermin.nic.in/acts_notification/energy_

The Ministry of Environment and Forestry notification issued on July 2004

http://www.pcra.org/English/aboutus/default.ht

Renewable Energy Plan/Policy:

http://mnes.nic.in/frame.htm
http://www.beeindia

Appliance testing & (comparison) labeling:

http://www.bis.org.in

National Energy Labeling Programme in May 2006:

http://www.clasponline.org/countryinfosummary.php

Building sector voluntary agreements:

www.ecohousingindia.org
http://www.epa.gov/eeBuildings/india/index.htm
http://www.teri.res.in/core/griha
http://www.dc.lbl.gov/india/buildings/index.html

The Institute's Activities

Training Programmes conducted

• In-house Training Programmes

Build Your Structure Waterproof

Date : 22nd & 23rd July 2010

Attendees : Ambuja Cements Ltd, Sainath Developers, S.P. College of Engineering, United Buildcon, Saifi & Associates, Crystal Industrial Syndicate Pvt. Ltd, Hamisar Healthcare International Institute for Population Sciences.

• National level Joint Training Programmes

Waterproofing of New Buildings

Date : 19th June 2010
Jointly with : Indian Concrete Institute (ICI), Pune
Venue : ICI, Prabhat Road, Pune

Cracks in Concrete and Crack Repairs

Date : 25th June 2010
Jointly With : Sardar Patel College of Engineering (SPCE), Andheri (W), Mumbai
Venue : SPCE, Andheri (W), Mumbai

Construction Chemicals – Waterproofing & Repair Applications

Date : 28th June - 2nd July 2010
Jointly with : Ministry of Micro, Small and Medium Enterprises (MSME)
Venue : MSME Development Institute, Sakinaka, Mumbai

Corrosion in Concrete & Protective Measures

Date : 7th Aug 2010
Jointly with : Indian Concrete Institute (ICI), Pune
Venue : ICI, Prabhat Road, Pune

Building Maintenance - Waterproofing & General Repairs

Date : 12th & 13th Aug 2010
Jointly with : Building Materials & Technology Promotion Council (BMTPC)
Venue : India Habitat Centre, New Delhi

Structural Diagnosis & Condition Assessment of RC Structures.

Date : 28th Aug 2010
Jointly with : Sardar Patel College of Engineering (SPCE), Andheri (W), Mumbai
Venue : SPCE, Andheri (W), Mumbai

Construction Chemicals for Water Proofing Application and Repair

Date : 9th Aug to 13th Aug 2010
Jointly with : Kasturba Mahila Khadi Gramodyog Vidyalaya (KMKGV), Pune
Venue : KMKGV, Pune

• Corporate Training Programmes

Build -Your Structure Waterproof

Organisation : Marathon Realty Private Ltd
Date : 27th July 2010
Venue : Mulund, Mumbai

• Healthy Construction Lecture Series Programme (HCLS)

Organized a special lecture on "Sustainability and Green Construction Practices" by Dr. Gajanan M. Sabnis, an Emeritus Professor from USA, in Bangaluru and Mumbai on 4th and 5th June 2010 respectively. Both the programmes were well attended and appreciated by engineering fraternity of both the cities.

Training Programmes, Seminars & Publications

Training programmes for Oct - Dec 2010

DFI-SPR has scheduled the following training programmes for the up-gradation of knowledge base of Practising Engineers, Waterproofing and Repair Contractors, Consultants, Architects, Faculties and Students from Engineering Colleges.

Sr. No.	Date	Venue	Topic	Fees	Details of the topic
1	8th Oct 2010	DFI-SPR, Andheri (E), Mumbai	Tackle Cracks in Structures - A Holistic Approach	Rs. 1500/-	• Manifestations of Distresses in RC Structures • Types of Cracks in Concrete Structures • Corrosion Cracking • Repair Materials and Methodology
2	23rd Oct 2010	Sardar Patel College of Engineering, Andheri (West), Mumbai	"Waterproofing of Concrete Structures"	Rs. 1500/-	• Waterproofing - Concepts and Understandings of Building Envelope • Good Construction Practices for Durable Watertight Structures and Conventional Waterproofing Techniques • Waterproofing of Critical Building Areas • Waterproofing of Dams and Tunnels - Case Studies • Modern Waterproofing Materials and Systems
3	9th & 10th Dec 2010	DFI-SPR, Andheri (E), Mumbai	Structural Diagnosis and Condition Analysis of RC Structures	Rs. 3000/-	• Distresses in RC Structures • Condition Survey • Dignostic Techniques • Methods of Non Destructive Tests • Damage Rating • Repair Techniques

Corporate Training Programme

In addition to the above scheduled programmes, we do organize separate corporate training programmes on specific topics as per the needs of the customer.

Healthy Construction Lecture Series

Self Healing Concrete as Repair Material in Concrete Structures

Speaker : Prof. Nele De Belie, Professor in durability of cement bound materials in Ghent University and Technical Director of The Magnel Laboratory for Concrete Research, Belgium

Venue & Date : Hotel Hindustan International, Kolkata on 23rd September 2010
Hotel The Park, New Delhi on 24th September 2010

Publication

International Journal of 3R's (Repair, Restoration and Renewal of Built Environment)

Journal Scope

To promote and coordinate developments and practices for enhancing the service life of Built Environment.

Subscription

The subscription of this quarterly journal is from January to December for Rs. 1200/-. Please contact our Editorial office for subscription form.

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Contact Details:

Mr. Tirtha Pratim Banerjee
Phone: (022) 28357683
Mobile: 9930650145
E-mail: tirtha.banerjee@pidilite.com

Ms. Neelima Suryawanshi Sali
Phone: 022 -28357979
Mobile: 9969354030
E-mail: neelima.sali@pidilite.co.in

VISION

To become a premier national knowledge and skill development centre for capacity enhancement in waterproofing and other areas of repair, restoration and renewal engineering based on sustainable and green technologies.

MISSION

To act as a platform of national and international networking for sharing of knowledge and practices in the fields of waterproofing, repair, restoration, and renewal engineering in the context of life cycle assessment of the built environment for adoption of best practices by the country's construction industry.

DFI - SPR : ACTIVITY CHART

Capacity Enhancement Services

Networking with National & International Organisations	Development of Database	Formulation of Guidelines for Standardization of Codes of Practices	Compilation of Global Best Practices in the Fields of Relevance

Knowledge Dissemination Services

Design of Training Courses for Different Levels and Development of Training Modules			Publications
Refresher Courses for Engineers	Tailor made Training Programmes for Corporate Bodies	Academic Courses for Educational Institutions	International Journal
Students Awareness Programmes	Seminars and Workshops	Entrepreneurial Training	Technical Newsletter
Workers Skill Development	Technology Demonstration	Distance Education Correspondence Courses	Manuals / Guide Books

Laboratory and Advisory Services

Non Destructive Testing	Partial Destructive Testing	Concrete Petrography
Health Assessment of Buildings	Consultancy for Repair and Restoration	Heritage Conservation

Editorial Advisor : Dr. A. K Chatterjee, Director, Dr. Fixit Institute of Structural Protection & Rehabilitation
Printed & Published by Dr. Fixit Institute of Structural Protection & Rehabilitation,
Ramkrishna Mandir Road, Post Box No.17411, Andheri (E), Mumbai 400 059 INDIA. Tel +91-22-28357149

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The Editor – 'Rebuild'
Dr. Fixit Institute of Structural Protection & Rehabilitation

C/o **Pidilite Industries Limited**
Ramkrishna Mandir Road, Andheri (E), Mumbai 400 059
Tel : 022 – 2835 7973 / 2835 7149
E-mail : suresh.pattanaik@pidilite.co.in
info@drfixitinstitute.com
Visit us at : www.drfixitinstitute.com

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