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Editor
Prakash Gole

Guest Editor
Mahesh Rajwade

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The Ecological Society

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Prakash Gole, Chairman
The Ecological Society
B-2, Jayanti Apartments
Near Ratna Memorial Hospital
Senapati Bapat Road, Pune 411 016
Telephone : (020) 25677312
E-mail : ecological.society@gmail.com
Website: www.ecological-society.org
Blog : http://ecologicalsociety.blogspot.com

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2035 Sadashiv Peth
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Foreword

The Ecological Society and its founder Shri Prakash Gole have tirelessly spread the message of sustainability through the Society's academic curricula and related field activities since last three decades or so.

Sustainability has become a catchword which is slowly turning into a cliché. But fortunately many institutes, individuals, including architects are trying to understand this concept in its depth and shape their work and professions accordingly. Late Mr. Laurie Baker, and late Mr. Nari Gandhi were amongst such persons. Their no-nonsense yet beautiful buildings have inspired many architects over the past few decades.

But now the time has come for the entire architectural fraternity to think and design with even deeper issues like energy use, appropriate material use, climatology, dying local skills, etc.

For example a student of architecture is told to use wood sparingly because it is a 'precious natural material'. Whereas wood is the only renewable building material and that's why a sustainable one. But at the same time the architect must persuade the client to plant and nurture, native timber species so as to mitigate the cubic content of wood proposed for the building project. Now these species again have to be diverse and local timber species, otherwise we have infamous examples like monoculture black forests in Germany. Here, one is also reminded of teak plantations which were an investment fashion a decade ago in Maharashtra state. These manure aided, forced growth plantations proved to produce sub grade, weak teak eventually.

Another issue which has been haunting me is the usage of bricks. It is alright to use the bricks in the flood planes of Ganga, Yamuna, Narmada , Mahanadi etc. where the soil depth is at times two to three kilometers. But I have always wondered whether we should encourage the farmer from the plateaus of Southern India to earn a fast buck by selling the cultivable soil to be burnt. The experts tell us that average alluvial soil depths in Maharashtra state are not more than 3.0 Meters or so. These facts need to be paid attention to by the building industry.

The last decade has witnessed world over debates, dialogues, revolving around such catchwords as global warming, biodiversity, pollution etc. The issues embodied in these words, till a few years ago were looked upon as the subjects of indulgence of the rich and wealthy or if at all, connected to the activists like Medha Patkar or Sundarlal Bahuguna.

But somehow over the past few years the media and the decision makers took it upon themselves to hype these environmental issues. As a result more and more numbers of people have become aware of the importance and ferocity of these words (if not the real issues in the back ground). Moreover the common citizen has remained in a constant awe of this as he /she has no idea about how one is going to tackle this. But the overall awareness has generally resulted in many proactive actions.

The 'Green Building movement' has come about as a result of such awareness. This concept like many other commodities was imported from the West into our country. The Indian architectural fraternity in its eagerness to obtain 'green certification' forgot a simple fact that we are a tropical country. The Sun, soil and the rains here are different, so is the diversity of people and other living beings. We also overlooked a fact that these are the solutions in the form of mitigations for the problems created by the over-developed countries from the temperate climates and that these are not really valid for a tropical and developing country like ours.

Apart from this, we along with the West overlooked one more thing: The basic laws of Thermodynamics which tell us that matter and energy are finite. Their 'instant entropic conversions' by the human technology are leading the human race and the biodiversity to the path of destruction. On this background it is a forgone conclusion that sustainability is next to impossibility especially in the present economic structure which does not take in to account these basic facts. The inevitable life style which has emerged out of this economic system has left 67% of our population with per capita income of Rs. 20/- per day.

This is not the place to discuss or expand on this subject, but honestly if our country's decision makers and fellow countrymen take a deep breath, think and act, our world could be really a beautiful place to live in.

With these sentimental and wishful words I would urge the reader to go through the following pages. This year's Journal tells us how some of the Indian architects and engineers have dealt with the issues of architectural sustainability. These are the designers who have given an independent thought, knowingly or unknowingly – to the issues of sustainability in an Indian way. These may not be the ultimate solutions but I feel the thought behind is important and path breaking.

There are far deeper issues like the limits to the growth of the cities in proportion to their hinterlands, followed by the welfare of farmer and the development of infrastructure in the villages yonder. These are beyond the purview of an architect. Only a strong leadership / political will coupled by strict governance can make this happen. However the public awareness and resulting pressure waves always help give directions to the decision makers.

More articles and examples could have been included in this issue but for the constraints of space and time. The Ecological Society intends to include such and more articles in the next issue which would deal with the topic of sustainable urbanity.

We welcome the readers to write to us at the Society's office or through the e-mail : ecological.society@gmail.com

Mahesh Rajwade
Trustee
The Ecological Society

Sustainable Building Practice : Design Of The Practical Evaluation Tool – PET

By the year 2001, we had completed almost nine years of Architectural Consultancy. All along we had kept on working along the principles of affordability and environmental friendly construction. The projects of Late Mr Laurie Baker had acted as guiding principles for us. Our interventions by the way of use of local skills and materials, use of appropriate technology by the way of filler slabs, rat trap bond etc were being appreciated.

Around the same time period, the concepts of green and energy efficient buildings, sustainable architecture had started taking roots. Austrian architect, artist Hundertwasser was one of the early designers to design the sustainable building, his famous quote being- 'If a man walks in nature's midst, then he is Nature's guest and must learn to behave as a well groomed guest.'

The efforts in the direction of green architecture were made globally, however there was no standardized methodology of appropriately evaluating, measuring the sustainability of a building.

In November 2001, we had such an opportunity to study and find out a method of measurement for sustainable building practices. Under the initiation of Swiss Development Corporation (SDC India), Swiss Consultants (SKAT), and Development Alternatives (DA Delhi), a two day workshop was organized by the local partner MITCON. This was held in Lonawala near Pune , Maharashtra State. Twenty stake holders comprising of architects, structural engineers, policy makers from the government along with businessmen, investors, bankers connected with building industry participated.

This workshop consisted of five modules :

1. Introduction of the participants and the purpose of the work-

shop.

2. Understanding the word sustainability in the context of architecture and construction.
3. Identifying and finalizing the indicators of architectural sustainability.
4. Applicability of the indicators, and graphic mapping of the indicators.
5. The future action and implementation.

While discussing these modules few relevant topics were touched upon like – Lower building and maintenance costs, Simplicity in building maintenance, Healthy interiors and environment, Recycling of materials (cyclic construction process), embodied energy, Life cycle analysis.

A few examples were cited and discussed : water harvesting, climate oriented designs, use of alternate energy, maintaining biodiversity in the surroundings.

This workshop was essentially to develop a module for Pune region with an intention to develop an appropriate module for other regions eventually.

Three categories were finalized while working on the indicators :

1. Ecological, 2. Financial and 3. Social indicators.

The items emerged during the brain storming session for each category were as follows :

Ecological Indicators

1 Energy (coal, petroleum, renewable),
2 Air pollution (CO_2, SO_2, CFC, SPM, NO, HC),
3 Water and soil pollution (heavy metal deposits, BOD/COD, turbidity, pathogenic vegetables),
4 Recycling, reusing
5 Use of non- hazardous industrial waste,
6 Disruption to wild life,
7 Use of solid waste in building as material
8 Life cycle analysis (bio-degradable / renewable)
9 Construction
10 Operation

11 Water usage (all material usage)
12 Safety (building design natural disaster resistant)
13 Maintenance (use of resources for maintenance)
14 Durability
15 Landscaping using appropriate material
16 Portability
17 Persistent chemical radiation, Ground water depletion
18 Biodiversity
19 Use of industrial waste (Non-hazardous)

Financial indicators

1 Plant/ product life cycle
2 Advertising
3 Demand generations
4 EMI
5 Prevailing lending rates
6 Rate of interest on loan
7 Inflation rate %
8 Credit rating
9 Operation cost
10 Cost of safety
11 Waste control
12 Process automation cost
13 Exchange cost
14 Legal costs
15 Customer
16 Insurance
17 Project feasibility
18 Asset value
19 Land value
20 Tax-holiday
21 Working capital
22 Profit margin
23 Time cost
24 Consultancy charges
25 Subsidies
26 Amenities cost
27 Return on investment
28 Initial cost
29 Technology cost debt/ equity ratio

Social indicators

1 Job creation potential
2 Labour welfare
3 Up-gradation of skills
4 Health and hygiene
5 Charitable systems
6 Income base griping
7 Affordability
8 Commuting time / cost
9 Anthropological survey
10 Quality of life
11 Socio-economic profile
12 Gender friendliness
13 Empowerment
14 Replicability and exclusiveness survey
15 Innovation survey
16 Maintenance system
17 Interaction with nature
18 Structural set up
19 Appropriate technology
20 Government / political influence

21 Leadership
22 Role models
23 Legal compliance
24 EGO
25 Skill up-gradation
26 Continuity of craft and tradition
27 Indignity
28 Child friendly
29 Handicap friendly
30 Elderly friendly
31 Safety and security
32 Ease of communication
33 Flexibility and adaptability
34 Access to infrastructure facility
35 Family values
36 Social awareness
37 Community needs
38 Taboos and phobias
39 Social fabric
40 Community
41 Privacy
42 Social incentive
43 Symbolism
44 Religious sensitivity
45 Cultural acceptance
46 Neighbourliness
47 Cultural events
48 Aesthetic sensitivity
49 Sense of motivation
50 Community participation
51 Literacy

Using these indicators three existing buildings of different nature were analyzed.

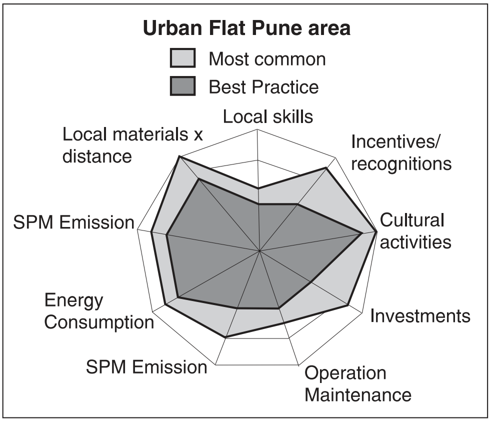
1. Residential apartment in urban area.
2. Residence in rural setting
3. Industrial building in MIDC area

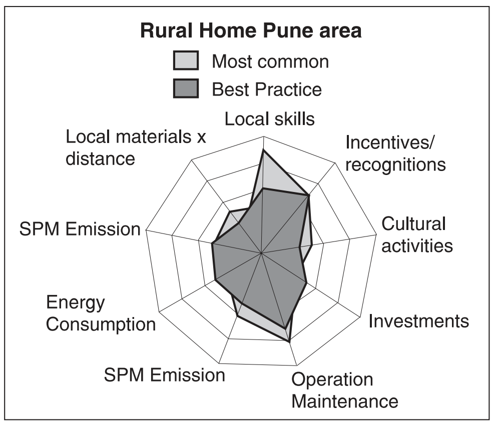
The participant group applied the list of indicators to evaluate these buildings using a workable scoring system. The most common and prevailing building practice acted as the existing reference, while the best available and ideal practice formed the central (darker) figure of the chart. This prototype scoring system was named 'Practical Evaluation tool' or PET

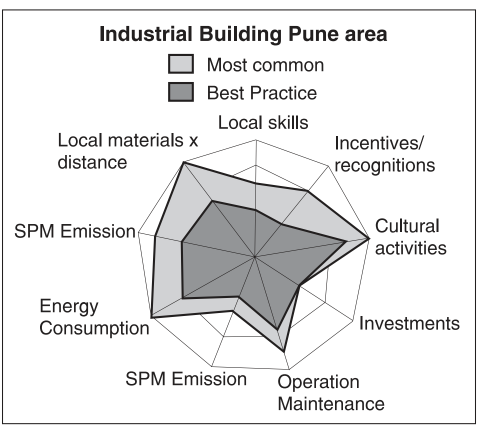
Following are the graphs or 'Radar Charts' for the buildings which are self explanatory.

Following 'future action plan' was decided upon :

1. The participants could form region-wise platforms incorporating important stake holders of that particular region. Make use of the common understanding emerged during the work-


Urban Flat Pune area
Most common
Best Practice
Local skills
Incentives/
recognitions
Cultural
activities
Investments
Operation
Maintenance
SPM Emission
Energy
Consumption
SPM Emission
Local materials x
distance


Rural Home Pune area
Most common
Best Practice
Local skills
Incentives/
recognitions
Cultural
activities
Investments
Operation
Maintenance
SPM Emission
Energy
Consumption
SPM Emission
Local materials x
distance


Industrial Building Pune area
Most common
Best Practice
Local skills
Incentives/
recognitions
Cultural
activities
Investments
Operation
Maintenance
SPM Emission
Energy
Consumption
SPM Emission
Local materials x
distance

shop as a basis for further discussions.

2. To consolidate and fine-tune the PET introduced in this first workshop and to derive the methodology of application of each indicator, a second workshop was needed. Applying the refined PET on select buildings and documenting the findings was the aim of the second workshop. A core group from the first work shop was formed to spearhead the activities of the second phase.

The Second Workshop

This was held in May 2003 in Panchgani. The workshop resulted in a clearer definition of PET in terms of measurement systems of the indicators, units of measurement, and scoring of indicators for graphical depiction. The outcome was circulated to a larger stake-holder group for their comments. The comments were duly incorporated. Each core group applied the final PET on different types of buildings comprising of residential, religious, industrial and institutional. The results were recorded.

For the reader's benefit, a brief methodology for establishment of the three Indicators is stated below.

(While establishing the final 'Panchgani Indicators' some issues remained unresolved like the weight of some of the indicators. But the general opinion was that the ill effects of any error of judgment in such matter would be insignificant if the 'comparative' nature of results was understood by the users.)

1. The Ecological Indicators

Sr.No.	Indicator	Measurment unit
1.	Energy	KW hr / M2
2.	Resource cycled waste generation	Kg / sq.mt / Year
3.	Water management	Kilo-liter/sq.mtr./year
4.	Renewable energy	%
5.	Soil conservation	%

2. Financial set of indicators comprised of

1. Net investment
2. Operation and maintenance cost
3. Return on investment
4. Debt equity ratio

3. The Social Indicators

1. Employment Generated.
2. User response
3. Recognition and awareness
4. Labour Welfare
5. Cost of degradation.
6. Appropriate Technology.

Future plan was to get the PET certified and accredited by the government and other institutions like BIS, ISO, BMTPC, etc.

It was also planned to convince the government and statutory officials to offer incentive, recognition to the uses of PET. Unfortunately, in spite of the subsequent efforts in this direction, this did not materialize.

Rahul Ravat

Note : The photographs on page 29, 30 and 31 are of an independent bungalow project at Pandharpur by architect Rahul Ravat.

Mere Wala Green : Explorations Of A Design Practice Using Common Knowledge And Common Sense

The Scenario

'Green Buildings' is the latest buzz word in the field of built environment. It seems to have caught on like wild fire in the print media, in the electronic media and most importantly, amongst the fraternity of builders and clients, for homes, offices, institutions, and many other buildings.

'Green' colour, however, has acquired many a hue and many a definition. Architectural practices are fast becoming agents of change from designing buildings of any other colour to 'Green'. Utility Consultants are also competing with each other for maximum numbers of Green Awards. 'Green' products are emerging faster than the users have capacities to absorb them. Consultancies for designing 'Green' Buildings, which get recognition of Platinum, Gold or Silver Awards, have emerged as a specialized profession, with lucrative earning potential in the preparation of 'Green' Buildings simulations.

It appears that in the near future, those who are not in a position to call themselves 'Green', may be considered as outcasts in the industry.

What are 'Green' Buildings

'Green' buildings is a U.S. initiative, with roots in 1994, through organizations known as Leadership in Energy and Environmental Design (LEED), as well as the U.S. Green Buildings Council (USGBC). They began to pursue this extremely laudable cause of addressing the levels of unsustainable consumption in the U.S., and making efforts to bring them down to more acceptable level of sustainability. They established targets for designers as well as manufacturers and gave incentives of certifications, awards and accreditions to buildings / professionals.

This has led to new buildings being designed to follow such standards / targets, in the developed world, to begin with, and also in India since 2004. In India the cause is carried forward by the Indian Green Building Council (IGBC), which started with adopting the U.S. standards even for Indian buildings. They have now begun to alter some of these standards for Indian conditions. However, majority of these standards / targets still remain anchored in the U.S. Context.

'Green' or 'Mere Wala Green'

Sustainability or 'Green' Buildings can be interpreted in many different ways. What is desirable for one country may be excess for another, and vice versa. Its meanings and understanding will vary according to its context. India has suffered considerably during the past century by adopting directions appropriate for other countries, and using materials not entirely appropriate for their own context. As a nation, it has paid a heavy price, and continues to do so, creating enormous pressures on its resources. Most of the Built Environment of the pre-independence era can, even today, pass through the sieve of what we refer to as 'Green' Buildings. It is therefore necessary to initiate dialogues on what constitutes 'Green' Buildings for the various regions and climates of India.

Coining the term 'Mere Wala Green', is our attempt to clarify to all concerned in the building industry, the architects, the engineers, the interior designers, the builders, the products manufacturers as well as owners, that 'Green' is only a direction for achieving greater sustainability, and not a recipe in which, if you use the identified 'Green' products it will result in a truly 'Green' or sustainable buildings for any context.

Consequently 'Mere Wala Green', to us, means

- Understanding sustainability in the context of India and its regions.
- Attempting to understand what constitutes 'Human Comfort' in buildings.
- Questioning the needs, identifying their optimum levels in long term scenario, and taking the design provisions to that level only.

- Ensuring what is sustainable today, remains that way in decades to come.
- Ensuring that sustainability is not only in parts but also that way holistically.
- Maximizing the use of traditional wisdom in design, wherever applicable, because it represents the knowledge about the long term behaviour of materials, their strengths as well as weaknesses.
- Assessing all new technologies for their long term impact in the context of India and its development priorities, before accepting them for use.
- Being aware of the embodied energies of the materials, before we specify them.
- Taking the decision making processes to measurable levels, in order to make our choices judiciously.
- Taking the Savings' benchmark targets closer to the minimum standards of Provisions.
- Addressing all the above issues through the sieve of value engineering, for the specific context of the built environment.
- Pursuing Goals, not Means.

The Approaches, 'Top Down' and 'Bottom Up'

The 'Green' Buildings objectives are pursued with two distinctly different approaches namely, the 'Top Down' approach and the 'Bottom Up' approach. Both are relevant as well as possible, in the Indian context, with varying degree of applicability.

The 'Top Down' approach is the one which has been pursued by the USGBC and IGBC. It is :

a) More popular in the current scenario;
b) Concentrates more on how much energy is saved;
c) Accepts Western understanding of sustainability easily;
d) Uses high technology innovations, materials and products;
e) Driven by 'Green' brand and accompanying recognition;
f) Recognition based on 'Intent', rather than 'Performance'; and
g) Necessitates Experts' inputs and simulations.

Most of the standards or targets arrived in this approach, are geared to reduce the high energy consumption levels. This appears to be an acceptable approach for most of the developed world. However, what is observed in the Indian Context is that the resultant 'Green' Buildings are not 'Green' enough. They still have room for further savings in energy consumption.

The other approach, as understood and practiced by us, is the 'Bottom Up' approach. This has been practiced in India for many centuries, and has already been proven to be highly sustainable. It is :

a) Less Popular in the current scenario;
b) Concentrates more on how little is consumed;
c) Pursues the Eastern understanding of sustainability, and questions the Western understanding;
d) Uses Low technology innovations, materials and products;
e) Is not driven by 'Green', or any other brand;
f) Recognised as based on 'Performance' and not just 'Intent'; and
g) Necessary to use of Common knowledge and Common sense

We have realized in our practice that the two most important and readily available tools to achieve the Mere Wala Green Buildings are the use of common knowledge and common sense, available to all professionals. They could be further supplemented progressively with innovations, trial and errors approach, and/or scientific decision making processes, as needed.

Explorations of the 'Bottom Up' approach

Case Study – 1 Torrent Research Center : Use of Common Knowledge + Common Sense + Innovations + Trials and Errors + Scientific Decision Making Processes.

This Pharmaceutical Research Laboratory, located in Ahmedabad, is one of the largest successful experiments of passage cooling in Asia. The total built up area of the complex is approximately 20,000 Sq.Mts. 72% of the Central Building has achieved Human Comfort Conditions using Passive Downdraft Evaporative Cooling (PDEC), it has been able to establish extremely low levels of energy consumption, as well as Carbon Dioxide emission per square meter of area.

Its Significant Consequences are : a) 200 M.Tonnes of Air-conditioning load saved; b) Summers temperatures remain at 28°-32°C; c) 6 to 9 Air changes/hour on different floors in summer, including in the chemical laboratory; d) The temperature fluctuations inside do not exceed 3°-4°C, over 24 hour period, when outside fluctuations are 14º-17ºC; e) Humidity not allowed to exceed 65-70% in summer; f) Air Movement velocity not allowed to exceed 1.5 feet/second; and g) The building which was designed for 150 occupants in 1997, accommodated more than 600 users in 2005.

Its more Significant Consequences are : a) Everyone using PDEC areas breathe 100% fresh air, not re-circulated air; b) 250 Kva power is made available for someone else's use. c) The buildings have accommodated 250% additional users, without significant discomfort; d) The performance has been consistent over the past 10 years of its use and e) It gives healthy financial returns on investment in building costs. The entire cost of the building will be recovered from the electrical savings in 13 years of operations.

Post-Occupancy Survey of 2004-05, conducted by University of Technology, Sydney, Australia, and Victoria University of Wellington, New Zealand. Through Building Use Studies Survey 2005, who have a data base of 260 buildings worldwide.

A two page 'standard' questionnaire was selected for its capacity to provide feedback on a range of 63 variables, covering aspects of overall comfort, temperature, air movement and quality, lighting, noise, productivity, health, design, image and workplace needs. A total of 292 surveys were distributed, and 164 responses returned.

Performances of Torrent Research Center with 'Top Down' Approach

"The total energy consumption for PDEC and AC combined (includes light, equipment and AC for 2 blocks) for the 6 blocks in 2005 was 647000 kWh1. This averages to 54 kWh/m2 and 72 kgCO2/m2. Clearly the climate responsive approach to buildings such as Torrent comprising labs and offices with extended hours of operation in hot dry climate in India, the building is compared to available targets for commercial buildings – The Torrent energy consumption performance compares very favorably to the target for newly developed fully air conditioned building currently set in out to exceed 140 kwh/m2 for day use in a composite climate under the recently introduced environmental rating scheme TERIGRIHA and reported typical consumption in Indian buildings of 280-500 kWh/m2 or 375-670 kgCO2/m2. based on GHG coefficient of 1.34. (Singh and Michealowa, 2004)".

(As quoted in Post-occupancy evaluation of passive downdraft evaporative cooling and air-conditioned buildings at Torrent Research Center, Ahmedabad, India. by Leena Thomas and George Baird).

Case Study – 2 : Pathak's Bungalow (Use of Common Knowledge + Common Sense + Innovations).

An existing bungalow required an extension for an Artist Studio on the first floor. This was achieved by : a) Lifting the inclined tiled roof by 2 ft; b) Providing roofing sheets below the tiles to create an air gap for insulation; c) Constructing a Rat-trap external hollow wall to create ventilated cavity the new external wall, designed as a RAT TRAP hollow wall to create insulation; and d) providing small square openings in the exterior wall to allow air movement through the hollow part.

The experience in the words of the Owner, is : "a) In past 8 summers, we have not felt the requirement to get false ceiling; b) during the hot summer, while entering the studio one feels the room to be a bit hot, but it is just a matter of body to get adjusted in few minutes and then the room is comfortable; c) if the openings at top level of the room are opened up then it is more effective; d) by late evening this room becomes cool earlier than the other rooms in the house; e) we have not measured temperature, but it seems to be about 5 to 8 degrees C lower than the outside temperature during summer; f) we are not sure how much it has saved on electricity bill, but if we had not gone for such a design of walls and the air draft then we might have required A.C. in this big studio; and we do not think the cost would have exceeded 10% - 15 % more than the conventional construction".

Case Study – 3 : Digantar Rural School (Use of Common Knowledge + Common Sense only).

A Rural school in the peripheral village of Jaipur for Digantar Foundation is an example of application of the principles and understanding of the local materials and construction practices. 250 children are studying in this school since 1994. The school was designed with two sessions of half an hour advice by us to the Principal, at the beginning of the design, and at the beginning of the construction. On the basis of this discussion a plan was prepared by the Principal, who also prepared the cost estimates and got it constructed. Other than the advice, no additional inputs were required by the Client from us.

It was built within their budget of Rs. 80,000/-, for a built up area of 370 sq.mts. The per square foot cost of construction was less than the cost of 'A' quality white glazed tiles in 1994; less than the cost of six waterless urinals imported for an Indian Platinum Award Green Building in 2004; and less than one fifth of the consultancy fees charged by experts in 2008, for preparing the simulation of a 'Green' Building.

Summary of Case Studies

These are some of the case studies which establish that the 'Bottom Up' approach is more relevant, more efficient, more 'Green', more applicable to a wider range of built environment, and more contextual as well. It is our understanding that while both the approaches, the 'Bottom Up' as well as the 'Top Down', are possible to be implemented, the former has a much better potential to achieve the targets in the context of India.

In conclusion, 'Mere Wala Green' will lead to :

- Focusing on solutions for India's own needs, not any other country's.
- Finding our solutions, from our own resources.
- Finding ways of decreasing our consumption levels.
- Peeping into our own traditional wisdom, for simple cost effective solutions.
- Inviting Common Sense into our lives, instead of Experts.
- Avoiding short term solutions.
- Contributing to making responsible built environment, not Style Statements.
- Contributing to Nation building, instead of Consumption building.

Nimish Patel, Parul Zaveri and Panika team
for the
Green Building Congress 2008 : Conference on Green Homes
Confederation of Indian Industry (CII)
Mumbai. September 27, 2008.

Heritage Preservation And Environment Protection

In 1993 when I decided to relocate our 110 year old wada situated in the heart of Pune to a suburban location the thought uppermost in my mind was preserving the heritage and the feeling of well being and serenity that I got from living in it. My architectural training and experience of carrying out repairs to the timber structure of the older part of the wada (which was more than 200 years old) had made me aware that the structure was amenable to dismantling and being re-erected elsewhere. These members were dowel jointed. This made it possible to pry them open with a crowbar without much difficulty and re-assemble them. And that is exactly what I did systematically and with careful planning to create my new home.

The new-old house, 2000sq.ft in area, is much smaller than the wada and is more compact. It is, in fact, a contemporary house with modern conveniences which uses traditional method of timber frame construction. It retains individual rooms as they existed before which are now arranged in a different layout designed to suit my present needs and life style. The old, well seasoned teakwood members of the wada were in perfectly good condition and were re-assembled on the new site. In addition to posts, beams, joints and boarding I have re-used old timber windows, doors and the staircase as well. The total quantity of timber used for the new house is approximately 550cft. Since the timber members were re-used in their original form (keeping the old joints) the labour that was needed was mainly for re-assembling them except where small modifications were required to suit the new layout.

The old construction is based on a module called khan. Each khan is a space spanned by two adjacent timber beams supported by timber posts at both ends placed 6ft (centre to centre) apart. The wada was a two storey structure and so is the new house. Timber posts on the ground floor are 6″ X 6″ in size and on the first floor 5″ X 5″. Timber beams are 8″ X 9″ or 10″ deep depending on the span they support (10′6″ in some rooms and 14ft in others). The ceiling height is 9′9″. The beams have joists (3″X 4″) placed across them 12″ apart which support the boarding on top. The boarding is flat on the side that is seen from below and rough on the other as it is made of pieces left after fashioning posts and beams from timber logs. The teakwood has been treated with a coat of a mixture of linseed oil and turpentine.

A noteworthy feature of wadas is an internal courtyard. It helps good cross ventilation and admits mellow light in adjoining rooms. Narrow, vertical traditional windows with a low sill, just about 12″ from the floor, facilitate air movement at body level even when sitting and let adequate amount of light inside. Two sets of shutters, lower and upper, make it possible to control better the flow of air.

What was originally an endeavour to preserve the heritage has, I now realize, contributed to the protection of the environment. The recycling of old timber structural members, doors and windows has meant that no trees have been cut afresh to procure the teak. Re-using timber has reduced considerably the use of energy intensive materials such as cement and steel as no reinforced cement concrete (RCC) columns, beams or slabs have been cast. The use of cement and sand has been further reduced by leaving the external walls un-plastered from the outside as they were in the wada. Instead of thick walls built in mud mortar, rat trap bond has been used to construct external walls. This has not only performed the same function of reducing the heat transfer, it has also cut down the number of bricks used as the bricks are placed on edge (making each brick course 4.5″ high instead of the usual 3″) and there is a cavity in the wall. Above all, the earthy look provided by exposed brick walls and clay tiled roof is enhanced by the warmth and gentleness exuded by the teakwood.

Meera Bapat

Exploring Sustainability Through Dry Construction

"We cannot have ecology movement designed to prevent violence against nature, unless the principles of non-violence become central to the ethics of human culture."

Mahatma Gandhi

Introduction

When I decided to demolish my twin duplex residence and construct a three story apartment building I was firm on my decision to use steel for the structural frame of columns and beams and a composite floor consisting of trapezoidal metal deck with plain cement concrete poured over it, instead of conventional Reinforced concrete columns, beams and floor slabs. It was quite an outlawed thinking compared to the prevalent construction practices across India in general and Pune in particular.

I had a gut feeling that I would succeed in my attempt but I was also aware that only gut feeling is not enough. Construction is not a singular task. It is plural. "It needs two to Tango" as the saying goes. Similarly any construction project is an endeavor of many. Client, Architect, Structural Engineer and Contractor are minimum participants required for any building project. Depending upon the complexity of the project more consultants may be engaged.

Planning the Project

The construction system used for the project which I intend to discuss here is absolutely nonconventional. RCC framed construction is totally absent. Since I was the Client and the Architect there was no problem of convincing the client and half the battle was already won. The most difficult task was to find the Structural Engineer, who would spend time with me to come up with the Structural Design and of course the Contractor, who would construct a nonconventional building. By saying this I am not at all implying that in Pune there were no structural engineers capable of taking up this project. I needed a structural engineer who would spend enough time with me as a Client and as an Architect during the design and construction process. Structural design of RCC frame and Steel frame is not the same. I was fortunate to find both, the engineer and the contractor. Both were young and enthusiastic. It helped me. Considering that this was their first job of its kind, it was a job well done.

Honestly speaking concern of the Environment*, Ecology**, Sustainability** etc. etc. was not in my mind. I was firm about my decision of not using RCC elements above ground and steel underground. This was simply because Steel is more vulnerable underground than above. It is easy to monitor weather effects on it plus maintenance is also easier.

Today the terms environment, ecology, sustainability are not alien to us. Everyone must try to save natural resources and at the same time an attempt must be made to recycle anything and everything. Whatever material we specify as design professionals, we need to make sure that it is Eco Friendly.

Materials

The way of material selection: In any building construction, cement, sand, stone, steel, bricks (soil), wood, water are the principal materials used. The raw material required to manufacture the final products come from natural resources. Manufacturing process requires energy. Less the use of energy for the production of a product better it is. So when it is said that a material is eco-friendly its embodied energy is at an acceptable level. However, this is not the only criteria used to decide whether any material is Eco-Friendly. Its Sustainability is also taken into consideration.

Almost all buildings constructed are RCC frame buildings, meaning the columns, beams and floor/terrace slabs are of reinforced cement concrete. The filler walls are conventional clay burnt bricks masonry in cement mortar with plaster on both faces. The construction process requires thousands of liters of water of which more than half of the water is wasted. During construction the percentage of material wasted is very high. In short it is a very unsustainable construction practice. As against this the construction process used in this apartment building consists of a Structural Steel frame with profile metal decking with plain cement concrete floors/terrace. Fly-Ash Silicate steam cured brick masonry exterior filler walls and Metal stud/Gypsum board partitions as interior walls. Almost all of this construction requires minimal or no water. All the material is recyclable.

Now what is the difference between RCC frame and Structural Steel Frame? The material is different therefore its strength and weaknesses are different. The method of Structural design is different. Poured (concrete) RCC frame being homogeneous the connections between columns, beams and floor/terrace slabs are not designed separately. In the steel frame all connections are subjected to tensile, compressive or shear forces and are required to be designed individually.

The floor decking is required to be connected to the bearing beams by the use of shear studs. This process makes floor assembly composite and the beams, decking and the concrete act in unison. Metal decking used acts as structural element as well as permanent shuttering.

Metal stud /Gypsum board partition system is light weight. Ordinary 5′′ thick brick partition wall, both side plastered is almost 14 times heavier than 4″ this partition wall. Because of its uniform thickness it gives almost 12% more carpet area.

Ingredients of Fly Ash Silicate bricks are lime mortar, fly-ash which is abundantly available from industrial waste and silicate. These bricks do not need to be soaked in water and are denser, therefore water absorption is far less than conventional clay bricks. Because of its uniform size mortar joints can be well controlled. Also surface plaster thicknesses can be maintained to minimum required.

Services

P.M.C. water supply line is only used for portable water and separate line from bore well is used for W.C. flushing system. Rain water harvesting system is also deployed as well as solar panels for hot water supply.

Initial cost of the steel frame is higher than that of an RCC frame. However, concerns of sustainability tell us that Life Cycle cost of material is more important than initial cost. Construction time also has to be taken into consideration. Construction time for steel frame structure is almost 40% less than conventional construction process. Water usage is reduced by almost 80% which cannot be overlooked.

As mentioned earlier in this article that environment was not at all in my mind. However, may not be by design but by default this project has come out to be Eco-Friendly.

Time saved is money earned.

Glossary

* **Environment :** In general, environment refers to the surroundings of an object.

** **Ecology :** Derived from Greek Oikos (Home or dwelling place) and Logos (Study of Ecology) is the study of inter-relationships between biotic and abiotic organisms and among the individuals of biotic components.

*** **Sustainability :** Use / Consumption of natural resources in such a way that while fulfiling the aspirations of the present generation, it also takes in to consideration the aspirations / needs of the futute generations.

**** **Embodied energy :** the commercial energy (fossil fuels, nuclear, etc) that was used in the work to make any product, bring it to market, and dispose of it. Embodied energy is an accounting methodology which aims to find the sum total of the energy necessary for an entire product lifecycle. This lifecycle includes raw material extraction, transport, manufacture, assembly, installation, disassembly, deconstruction and/or decomposition.

Suresh Athavle

Sustainable Building Practice

A residence at Pandharpur

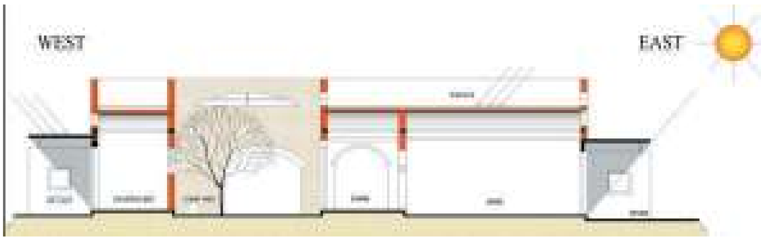
Rahul Ravat

Decreasing the exposed surface

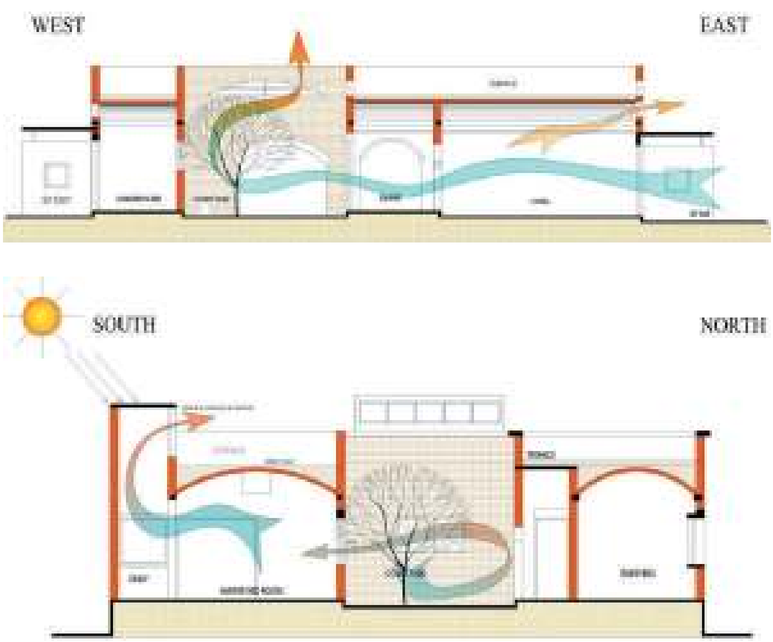
View from the south east corner

Sustainable Building Practice

Rahul Ravat



Increasing the shaded surfaces



Ventilation of spaces

Sustainable Building Practice

Rahul Ravat

View of the interior. As structure is load bearing the arches are part of the structure.

Mere Wala Green

Nimish Patel, Parul Zaveri and Panika team

Torrent Research Centre : External view of the air exhaust shafts

External view showing the small air inlets in the ventilated cavity wall, there are outlets at the upper level near the roof which are not visible

Mere Wala Green

Nimish Patel, Parul Zaveri and Panika team

Digantar school : External view (1994)

Digantar school : Roof construction detail showing Vertical Stone Patti, Wooden Ballis and Thatch Roof

Mere Wala Green

Nimish Patel, Parul Zaveri and Panika team

Digantar school : Internal courtyard when built (1994)

Digantar school : Internal courtyard (2004)

Heritage Preservation And Environment Protection

Meera Bapat

The 'khan' system with 6 feets span between beams

To ensure proper reassembling the wooden members were numbered before dismantling

Heritage Preservation And Environment Protection

Meera Bapat

The dismantled beam

The reassembled beam

Interior : Meera Bapat's house

Exploring Sustainability Through Dry Construction

Suresh Athavle

The completed structure

Exploring Sustainability Through Dry Construction

Suresh Athavle

Trivendram house under construction

Gypsum Board installed on one side of framing

Sustainable Built Environment – A Structural Engineer's Point Of View

B. V. Bhedasgaonkar

Precast ferrocement house – under construction

Completed one room kitchen house in ferrocement

Sustainable Built Environment – A Structural Engineer's Point Of View

B. V. Bhedasgaonkar

Material Consumption for Dome with 375 sft builtup

- Cement : 50 bags
- Steel : angles, plates and main steel removed after assembly
- Mesh :
  Weld : 150 M 2,
  Hex : 225 M 2
- Bricks : 800
- Murum :
  1.5 trucks
- Material costs :
  incl. Thermocol :
  65000
- Labour : 35,000/-
- Cost per sft :
  Rs. 300/-

Sustainable Built Environment – A Structural Engineer's Point Of View

B. V. Bhedasgaonkar

Wood wool board construction

It's All About "Green Attitudes"

Ar. Shirish Beri

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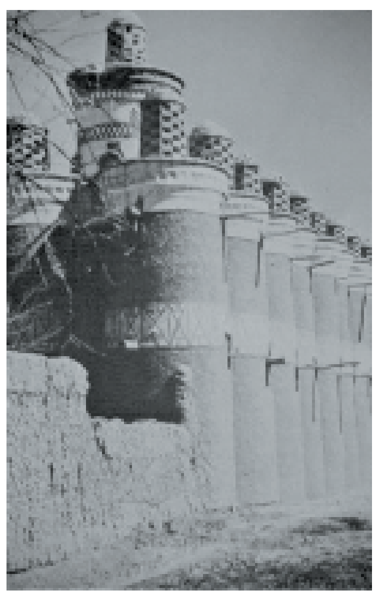


Sustainable Built Environment – A Structural Engineer's Point Of View

Introduction

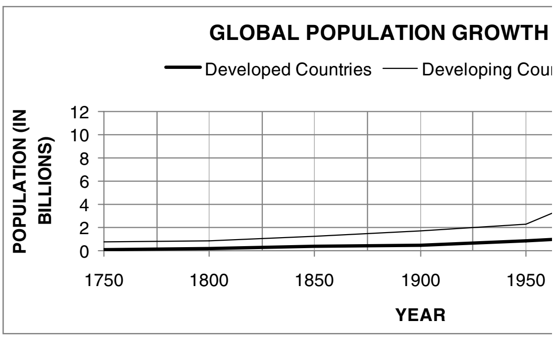
For the last several Billion years nature has nurtured the planet evolving complex eco-systems that recycle and conserve energy and materials. Sun is the source of energy . Waste from one natural metabolism is the input of another. Plants and animals live together in mutually inter-dependant ways.

Mechanisms for regulation exist which prevent overgrowth or dominance. Due to occasional climate change such as fire, earthquake, wind etc. species get wiped out and new species take over. Nature comes back to a balance position after such disasters and it takes thousands or millions of years. Meanwhile along came human beings. We are responsible for many changes affecting geosphere-biosphere such as salinity, deforestation, pollution, global climate change etc.

Consensus exists that we are responsible for climate change and a rising frequency and severity of storms, draughts, floods etc. Our presence in nature, with our present day lifestyle , is non stable and non sustainable. Driven by our intelligence, greed and arguably cheap fossil fuel energy and behavior like a new predator before which no living thing can stand, we are taking over.

Starting from a steam engine followed by oil, abundant energy and thousands of innovations later we hold a tiger called technology by its tail. It is bigger than we are and in its name five to six hundred billion tonnes of matter are moved about the planet to create twenty or thirty billon tonnes that we actually use. Resources are limited. Needs change and things we make and use get worn out and thrown out as waste. Vital earth systems are unable to cope and are rapidly going out of balance. Efficiencies and costing of Processes and products made do not account for value of natural capital consumed. (for example true cost of energy, water, sand, cement, steel etc.) There is an urgent need to reduce footprint of human beings.

Global Population Growth



In October 2004 a WWF report, The Living Plant Report 2004, says humanity is already consuming 20% more natural resources than the earth can produce. The Challenge of 21st century is learning to live within the means provided to us by the nature. There is ample evidence that increase in consumption per person and population growth have compounded to unsustainable levels.

Urban settlements in developing countries are growing five times faster than those in developed countries. Cities in developing countries are already facing enormous backlogs of shelter, infrastructure and services resulting in overcrowded transportation, poor sanitation and pollution.

Opportunity for change is greatest in the built environment which has the greatest material flows on the planet with the largest take and waste impacts. Architects, Engineers, Specifiers are uniquely positioned to take advantages of the changes that are occurring and take the rest of the supply chain into delivering sustainability.

Building Materials and Embodied Energy

Cement is a major source of CO_2 emissions. As seen in the

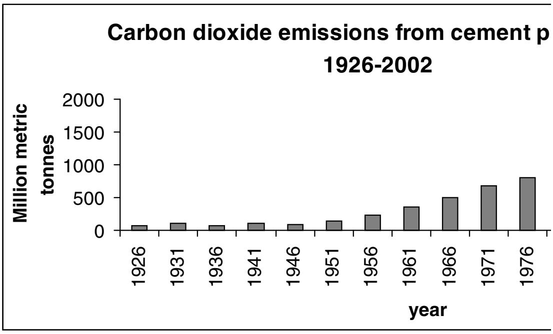
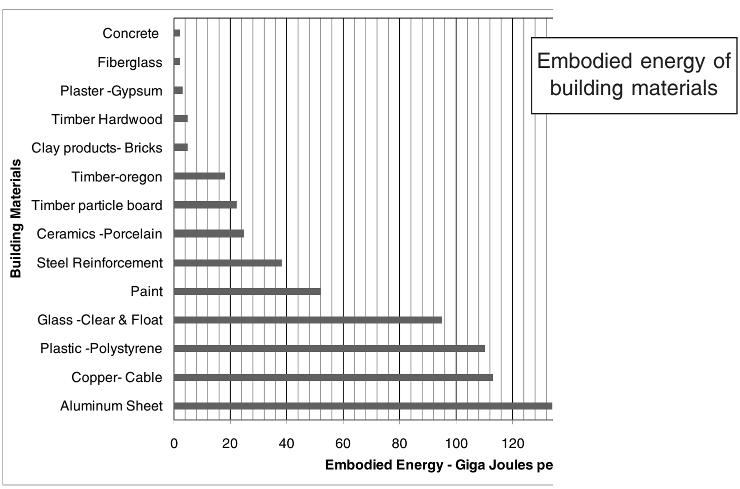
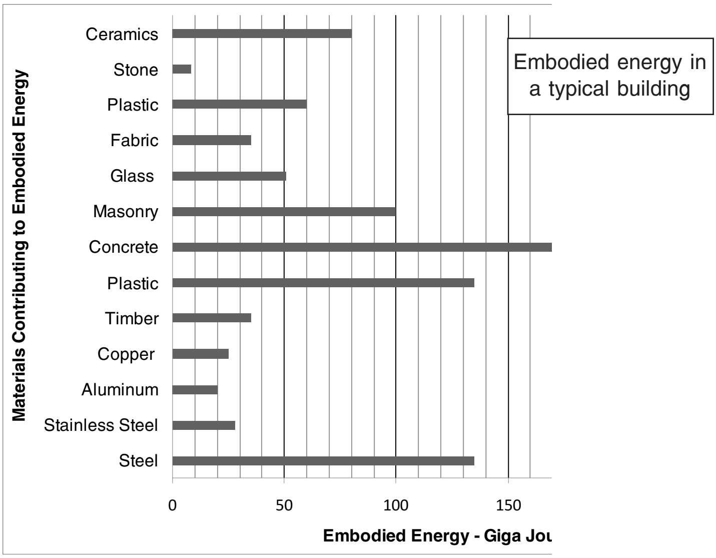


figure it has low embodied energy and relatively high thermal capacity compared to other building materials such as glass and steel (as seen in the graph). But it is the most widely used material on earth and hence the environmental impact is immense. (Gaga Joules per Ton is the unit of measurement.)



However, the graph on the next page shows the true picture. It shows the contribution of major construction materials in the embodied energy of a building.

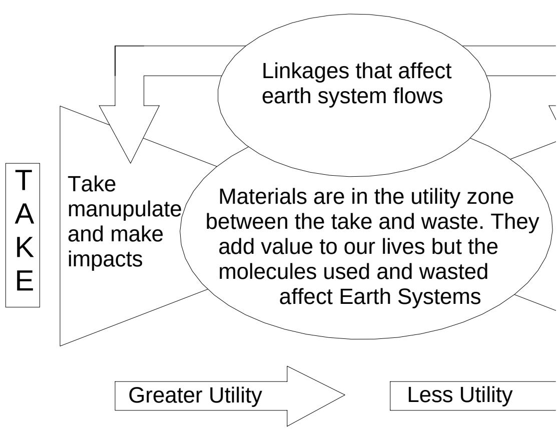
As can be seen, the contribution to the total embodied energy of a building of three construction materials, namely, Concrete, Masonry and Steel, is very high. They constitute about 50% of the embodied energy in the construction stage of a building. These three materials are also responsible for the structure on which the



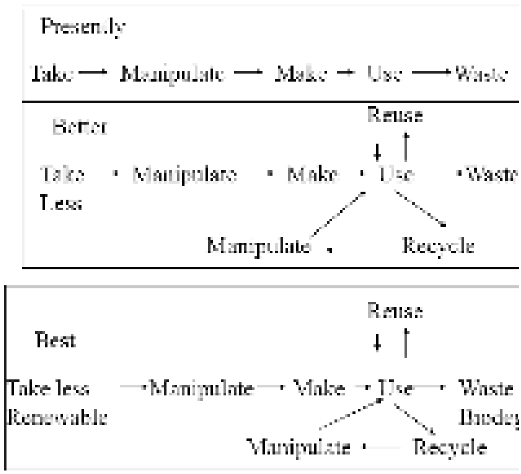
building stands. Essentially this means that optimisation/ finding alternative means of structural systems and design approaches could lead to substantial reduction in embodied energy and in making the structure sustainable.

TheProcess of Change

Our present day lifestyle use of resources can be summarized in the sketch below.



This should change to



This should essentially involve

- Reducing, re-using, recycling, recovering
- Use more renewable resources and less non-renewable resources.
- Re-engineering the materials we use.
- Changing molecular flows using non fossil.
- Realizing that Sustainablity is good business sense.

Sustainable Material for Built Environment

1. One of the first things to be done is to use lighter materials. This reduces the weight and hence the structural requirements of support systems and foundations. Lighter material also reduce energy requirement of lifting in place to upper floors. Enclosure elements such as walls can be made lighter - e.g. saw dust bricks in cement binder. Use of wood wool (made from shavings of small dia timber) can also be done in walling. There is a considerable saving in lifetime energies (as against embodied energies as construction stage) on account of high insulation values. Wood wool sheet houses with infill core provide a structural system as well as excellent thermal insulation of roofs and side walls.
   Wood wool boards are made from long wood fibrous strands and inorganic binders such as Magnesite bonded boards. Be-

cause of their versatile nature, the boards find large scale applications in low-cost housing, shuttering, sandwich type boards for insulation, false-ceilings, etc., A typical composition for making wood wool boards is as follows : Wood wool = 3 kg, portland cement = 6 kg, and water = 3 kg. For a board of 2.5 cm thickness the weight per square meter is 10 to 11 kg. This means it is 5 times lighter than brick masonry.

Cost-wise, wood wool boards are much cheaper than solid wood or other panels bonded with synthetic and natural adhesives. They are superior in physical properties such as thermal conductivity, sound absorption. They posses adequate strength, and are easy for handling. There is no need of machines for lifting and placing.

Apart from wood, a large number of agro-wastes like rice-husk, bagasse, hemp-flakes and coconut fibres have been recommended for manufacture of such boards. Current practices in India continue to use the traditional softwood species mostly Chir (Pinus roxburghii) with cement or magnesite binders. This happens due to lack of information on suitability of tropical hardwoods. *Please refer page 41 for examples of wood wool sheet roofing.*

Wood wool boards are classified as class-I fire resistant materials based on surface spread of flame tests. All these factors have contributed significantly to the adoption of this material in low cost housing and construction

2. Reduction in process energy in manufacturing can also lead to reduction in energy content. Use of stabilized clay bricks in place of fired bricks is one such example. Healthier materials such as carbonating concretes (Tec Eco cement concrete) limes etc are better alternatives.

   Tec Eco cements are manufactured with partial replacement of Portland cement with magnesia (MgO) which carbonates using atmospheric CO_2. Grinding and calcining are done simultaneously and at lower temperatures than ordinary cements. Magnesium has a strong affinity for water in solution and does not lose it readily in carbonation. This results in solid hydrated carbonates which are made up of 83% water and CO_2- a cheap sustainable binder.

   This is shown in the diagram on the next page.

   Capturing of CO_2 has been occurring in nature over millions

On the basis of the volume of building materials produced the figures are even better!

Eco-cements in porous products absorb carbon dioxide from the atmosphere. Brucite carbonates forming hydromagnesite and magnesite, completing thermodynamic cycle.	**Portland cements** 15 mass % Potland cements 85 mass % Aggregate Emissions 0.32 tonnes to the tonne. After carbonation. Approx. 0.299 tonne to the tonne.	**No capture** 11.25% mass % Reactive magnesia 3.75 mass% Portland cement 5 mass% aggregate Emissions 0.37 tonne to the tone. After carbonation approx. 0.241 tonne to the tone.	**Capture CO2** 11.25 % mass % reactive magnesia 3.75 mass % Portland cement 85 mass % aggregate Emissions 0.25 tonne to the tone. After carbonation approx. 0.140 tonne to the tonne	**Capture CO2. Fly and bottom ash** 11.25 % mass % reactive magnesia 3.75 % Portland cement 85 mass % aggregate. Emissions 0.126 tonne to the tone. After carbonation Approx. 0.113 tonne to the tone.

85 wt % Aggregates 15 wt % cement

Greater Sustainability →

0.299 > 0.241 > 0.140 > 0.113
Bricks, blocks, pavers, mortars and pavement made using eco-cement. Fly and bottom ash (with capture of CO2 during manufacture of Reactive magnesia) have 2.65 times less emissions than if they were made with Portland cement.

of years. Carbonates formed in sea water is an example. With capture of CO_2, use of organic fiber materials and fillers for strength and insulation, cementitous building material can eventually become a carbon sink. Organic fibers include wood fibers, saw dust, sugarcane bagasse, hemp, coir etc.

3. FERROCEMENT as an alternative to conventional reinforced concrete has been used for construction of dwelling units. Ferrocement uses much lower quantities of high energy content materials such as Cement and Steel.
4. Use of recycled materials such as Fly ash and blast furnace slag is on the rise. Geopolymers is another promising area.

Functional Elements to Serve as Structural Components

There are several other functional elements in a building that can serve the structural purpose of load-bearing other than enclosing elements such as walls. One such example is a window frame in Ferrocement. This eliminates structural element such as lintel (a small beam over window to support brickwork above it), and other functional elements such as window jams and window sills. Ferrocement staircases and tanks are other examples. Much of the dead weight from conventional staircases can be removed and the functional elements such as steps of staircase become the structural members. In water tanks made with Ferrocement the weight of the tank is about 10% of the water stored as against 50 to 75% in case of RCC and Masonry tanks. Here the functional element of enclosing water serves the structural purpose also.

A geodesic dome constructed using Ferrocement provides the same comforts as a conventional room but at a much lower embodied energy per unit.

Embodied Energy Comparison Normal Brick House VS. Geodesic Dome

(Energy is measured in MJ (Mega Joules)

Brick House with Roof Slab

			Energy MJ/ kg	Energy in MJ
Steel	900	Kg	42	37,800.00
Cement	10000	Kg	4.5	45,000.00
Bricks	4000	Nos	4.25	17,000.00
Aggregates	30	M3	175	5,250.00
				1,05,050.00 MJ

Ferrocement Geodesic Dome with steel angles removed after mortaring

Steel	165	Kg	42	6,930.00
Cement	3000	Kg	4.5	13,500.00
Bricks	800	Nos	4.25	3,400.00
Aggregates	9	M3	175	1,575.00
				25,405.00 MJ

Construction is done at 25 % of energy requirement of conventional construction.

A complete Ferrocement roof, wall, kitchen platform dwelling (having appearance like a normal house) can be constructed in Ferrocement after using much less embodied energy. These are do it yourself technologies and have the advantages of using local materials and virtually no machinery and electricity for construction.

Change in Design Approach

Most constructions 100 years ago were load bearing structure types. Some structures – particularly wooden frame and brick masonry structures (such as wadas and houses) were constructed as composite constructions. The wooden frames were used for spanning rooms while the walls were with brick/masonry/ clay or stone masonry stiffened with wooden members. Stilt floor was not required at all. Today the aspect of time has been playing a major role in deciding the construction system. An RCC structure is constructed first and later bricks are added as walls. These walls are only functional and do not serve any structural purpose. This allows the flexibility of knocking down walls and rearranging the living space inside. It, however, leads to walling elements not serving any structural purpose. Other than the use of 'low embodied energy' materials to make construction more sustainable, functional features should also serve, partially or fully, a structual purpose.

Limitations

The concept of using materials with low embodied energy is applicable primarily to low rise buildings. The energy economics completely gives way in case of high rise structures on several accounts. First of all the design parameters such as earthquake and wind, against which the structure is to stand, start governing the design, as against gravity for low rise buildings. This necessitates use of steel and concrete leading to higher embodied energy. Generally load bearing structures cannot be constructed beyond 3 stories. Materials such as stabilized clay blocks, Ferrocement, Wood wool sheet wall panels (with in-filled cores) have limitations on heights. There is a limitation of using such sustainable materials in today's cities where ground coverage is required to be minimized.

On this background, it can be concluded that sustainable building materials and construction techniques can best be used to improve quality of construction in rural and semi urban areas.

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Glossary

Embodied Energy : Total Energy used in material production, transportation and assembling into a building at construction stage.

Thermal capacity : Heat required to change temperature of a material by a given amount. This is low for steel and high for cement and concrete.

GJ : Giga Joules (Joules is a measuring unit for energy)

Masonry : Brickwork, Stone work, Blockwork construction in a building

Structural System : Arrangement of building components to transfer loads from self weight of materials of buildings, furniture, human beings, stored materials etc to ground.

Re-Engineering : Redesign of a product, by a consumer or user. to make them last for longer time with proper maintenance and repair.

Built Environment : Buildings, structures etc. along with the utilities within them.

Lifetime Energy : Energy used at construction stage as well as during lifetime (this includes embodied energy at construction stage as well as energy used for cooling, heating, lighting, maintenance etc during stage of use during lifetime of a building)

Infill Core : Typically a core filled with strong material to take loads enclosed by thermal insulating outer skin.

Shuttering : Material used for making an enclosure in which material like concrete is poured.

Thermal Conductivity : Ability of a material to transfer heat by conduction within its body. This is high for steel and low for wood and wood wool sheets. Low thermal conductivity gives better comfort in case of extreme climates.

Carbonation : Chemical process in which CO2 is absorbed and Carbonates (typically CaCO3) are formed

Calcining : This is process opposite of Carbonation. It is carried out in the process of making cement where Carbonates are converted to cement and CO2 is released.

Ferrocement : A construction technique in with several steel wire meshes are clamped together to get desired shape and then cement and sand mix is squeezed into the layers of meshes to get a strong building component.

Fly Ash : Ash remaining after burning of wood or coal

Blast Furnace Slag : A by product in the process of making steel. It has properties like cement.

Geopolymers : These are chains or networks of mineral molecules. Cements made from Geopolymers emit 80 to 90 % less CO2

Geodesic Dome : Spherical shape constructed using series of triangles connected to each other (like a football) – a concept popularised by Buckminster Fueller.

Stilt : Typically a floor with no walls (only columns) such as parking floor in an apartment building

B. V. Bhedasgaonkar

It's All About "Green Attitudes"

Sustainability has become such an overused, misused, fad word that we seem to feel that sustainable and green features can be added on to a design just like any tapestry or upholstery.

It is good to see this awareness amongst various strata of society including electrical and HVAC manufacturers and consultants. But this popular recent scenario tends to be based on an assumption of a high end, very comfortable, highly consumeristic, and thus highly exploitative life style where air conditioning, expensive gadgetry is taken for granted. Within these parameters, they introduce technological inputs (which many times are expensive with high level of embodied energy) to bring about some savings in energy consumption.

What I would like to discuss today are the basic issues like our attitudes which can minimize our consumption with genuine concern and mere commonsense.

In today's world, we seem to be having the perfection of means (lot of knowledge) but a confusion of goals (lack of wisdom).

Attitudes are what shape our goals and objectives in life – attitudes which could be born out of short sighted manipulative vested interests or out of wisdom-- the holistic understanding of life. Without the right attitudes, the sustainable becomes unsustainable and green becomes a greenwash.

Self restraint ("Sanyam") and self denial have become antiquated values in the "got mine" culture of the "me" civilization.

For sustainability, it is better to have fewer wants than larger resources.

We need to learn to make short term sacrifices for long term gains. Politicians are afraid to even suggest this – as they themselves also love living as if there is no tomorrow.

Today we see those people who consume so much energy and resources by their greedy, flashy lifestyles and businesses are those who are talking about sustainability. These are people who exploit these trendy words 'green' and 'sustainability' to increase their own profits which would in turn allow them to consume more and more.

We fail to grasp that this 'compulsive consumption' – retail therapy – happens as a relief from the lacuna of an unfulfilled life.

Thus, instead of learning from the mistakes of the overconsumptive developed countries, we see today an alarming growth in energy consumption of the developing countries. Whereas the growth in energy consumption in U.S.A is 1.3%, this growth in some developing countries has risen to 4.3%. The construction industry which consumes almost 50% of the total global energy has grown by 5% in the west as compared to 10% in the developing countries.

Gandhiji – when asked if Indians should have the standard of living of Britishers, said – "it took Britain almost half the world's resources to do so. – what would happen if we all have that standard of living?"

To prevent global warming and to have a sustainable future, truly green and sustainable environments need to be created. For this, green buildings with green ratings are suggested.

The basic intention of the 'green' rating in the western context is good. In India, It is desirable in cases where high tech parameters and air conditioning etc are a must like hospital O.T.s, I.C.U.s, pharmaceuticals, research labs and so on. There would definitely be some benefits if one goes by the green ratings.

Further, it is always better to buy truly 'green' products which have minimal footprint on planet earth – in the form of minimum energy used for the basic raw materials, the manufacturing process, the transportation, the marketing and finally for the actual installation and use. Fortunately we see some awareness and steps being taken in this direction by atleast a few.

But otherwise, today the word 'green' has became a marketing gimmick for materials that are sold with 'green points' that not only improve your green rating, but also tend to offset and partially make up for the higher expenses of these materials.

- A building that works well without air conditioning does not qualify for the LEED ratings. But a building that saves 10 TR out of 100 TR of air conditioning load gets its green points.

- A couple of green points can be further added only if you use a carpet with some recycled raw material content – whether we need a carpet in the first place is a different issue.
- A window with expensive, imported, high embodied energy, heat reflecting / absorbing glass that reduces the heat ingress by 25% gets the green points, whereas a simple window with a good shading chajjah that reduces the heat ingress by 50% does not take you any nearer the "green gold" or "green platinum" status. Simple planting of shady trees on this sunny side can also reduce the heat ingress considerably.

This kind of grading additions are done for numerous parameters – in order to categorise your building as 'green'.

I was invited to speak at an international green building conference, where the event venue was a large five star convention centre with extremely energy intensive, huge air conditioned halls and foyers. Many shops / stalls displaying hundreds of the same normal products with a 'green' adjective added onto it were set up in a very large air conditioned space. There were continuously running, energy guzzling escalators to go to the mezzanine level for lunch. No simple stairs was visible to walk up this 3 m height. As a speaker, I was put up in an air conditioned apartment with spacious living room, bedroom, dining, kitchenette, fridge, two L.C.D T.V.s, 3 telephones, part wooden flooring.

Could we not be a little more mindful in selecting appropriate venues and hotels and not fall for the unsustainable five star glitz?

The deeper we architects delve into the true meaning of sustainability, we realize that it is not just an add on gimmick to design but the design itself that is born out of a way of life, with compatible supporting attitudes.

"True green sustainable design happens as a result of a unified, holistic and compassionate attitude to life – attitudes of simplicity, empathy and caring concern for mother earth and for the present and future of all species – living and non living".

When I design, I have the following attitudes as a guiding force. They help me to design buildings that attempt to be truly 'green'.

- An attitude that does not equate good life with the number of goods that we have; - where outer simplicity brings about inner plenitude.

- An attitude that celebrates simplicity in life and in design. This frugality and simplicity need not be forced upon us, but they should be voluntary and spontaneous - arising from our true understanding of life, - where consuming less can be more liberating than limiting. A simple life style leaves more space for our spiritual renewal. Out of this simplicity is born a sense of freedom and spontaneity.
- An attitude of empathy, reverence and caring towards Mother Nature – its living and non living entities like water, air, soil, plants, animals and others. This care also extends for the future generations to come.
- An attitude that understands and recognizes the importance of the immeasurable spirit dimension in the design of any space.
- A spontaneous attitude that achieves the desired honesty in design rather than the make belief – superfluous pseudo add ons.
- An attitude that integrates various disciplines such as interior design, architecture, climatology, landscape design, ecology, economics, behavioral sciences etc. to find comprehensive and mutually compatible sustainable solutions.
- An attitude that understands and reduces this consumption of building related energy at three levels.

• At the end use energy level – here too well designed, well lit and ventilated buildings (with passive cooling) can help reduce energy consumption at the base level. This is where the new truly 'green' products as well as technological innovations in the process can help. e.g. The simple CFL fitting instead of an incandescent bulb - a heat recovery process during air conditioning to heat water and so on. Use of renewable energy from the sun, wind, water, bio gas and other sources will also help.

A simple life style will require less resources and consume less energy with its smaller space requirement as well as lesser gadgets that consume energy.

• At the embodied energy level – this energy is the energy used during the making, transporting and installing of any building material or product - use of simple, natural materials from the vicinity of the site will help reduce this energy. Similarly materials / products produced by simple, less energy consuming processes in not too far off places or by products of some processes will have less embodied energy.

In food, an apple imported from Australia would have greater embodied energy than a locally produced apple. Consuming optimum spaces, food, clothes, furniture, gadgets will reduce this energy consumption. If the same space is put to use for multiple functions during the day and night (a living room can double as a dining space as well as a bedroom), lesser building resources would be used and thus the building would embody less energy.

- At the recycled energy level – reuse of discarded materials, recycling of sewage for water, recycled use of an old structure for today's functions will reduce energy consumption at this level. Using products, which can be recycled and reused after their designated functions ceases, will also contribute.

At this point, I am reminded of the story of a monk and his master. The monk, whose robe was not good enough to wear anymore, asked the master for a new robe. The master, after seeing his robe, agreed and got him a new one.

Later the master went to the monk's room to enquire if he was comfortable and see what he had done with his old robe.

The monk had started using that as a bed spread. The old bed spread was used as a window curtain. The old curtain was being used for handling hot kitchen utensils, after which it would be used to mop the floor. This tattered cloth then would be made into wicks to light his oil lamp.

Fortunately, this does happen to some extent in many Indian/ Asian households too. But unfortunately this trend is being replaced by the 'throw away' waste making culture. Can't this reducing, recycling and reusing happen with our building materials too.

We can learn a lot about sustainability from various examples in nature and our vernacular architecture. In nature and in earlier traditional societies, designs happened to spontaneously maintain the optimum level in the consumption of all resources and energy – truly 'green' and 'sustainable' - This "optimum" or "green" level of consumption was the result of their basic attitude and idea about the kind of life they aspired to – holistic, caring, simple, frugal and honest.

All our designs of outer spaces have their true source in our 'inner space' ('The Chitakash') of our values and attitudes.

Take the example of today's ugly fertilizer plant that vomits toxic smoke and pollution in the air is in itself so very expensive to and make, has to guzzle so much energy to produce the chemical fertilizer that can be harmful to the soil and sub soil water. The attitude is that food is a commodity which can be produced faster with greater profits with the use of another commodity – the fertilizer. The well being of the other important constituents like the soil, air, water, birds, insects, becomes immaterial.

Whereas the ancient fertilizer, manure making unit made of these beautiful tall 2.5m wide mud towers in the African desert sets a wonderful example of sustainable, symbiotic production. The holes on top of the tower are entry points for the many pigeons which go inside to rest on the many pegs on the wall of these dark cool towers. While they sit, these pigeons also shit. Lots of pigeon shit gets collected inside the tower base. Bags of this organic, healthy manure are filled and taken to the fields by opening the rear door of this tower at ground level. In this case all the environmental constituents are happy – the birds, the insects, the soil, the water and air.

Can our designs evolve out of our sustainable attitudes which will help in taking us closer to nature, closer to other fellow beings, living creatures and to our own selves?

Isn't living sustainably synonymous with living more mindfully.

The world is not that which we inherited from our ancestors, but what we leave behind for our children and grandchildren.

Ar. Shirish Beri

Responsibility Of A Designer – An Ecologist's Perspective

Change the Prevalent Paradigm

Our cultural, religious, intellectual and economic traditions that co- evolved with Industrial Capitalism assume humans could and should transcend nature.

Poorly designed objects, structures, settlement patterns and spaces are responsible for environmental problems. Our environmental management processes remain geared towards predicting and accommodating growth and controlling nature rather than working with natural processes. Design fields remain unconcerned about the impact of designs on health of human systems and eco-systems. The built environment constraints or enhances social and personal relationships and our attitudes towards nature and society. Designers have the capacity to design healthy habitats that reduce demands upon nature and enhance life quality.

Designers could sway the apparent preference for conspicuous consumption towards a desire for low- impact dwellings as new status symbols.

Designers can also have a dramatic impact on reducing the material content of consumption and hence aggregate demands on the environment.

Design needs to shift from a paradigm of transforming nature to one of transforming society by improving life quality and relationships between all living things and built environment.

Design must integrate knowledge from other fields concerning human health and eco- system processes.

It should promote technologies, systems of production and construction methods that do not rely on natural capital, fossil fuels and harmful chemicals.

Construction Ecology

To create more quality of life with less materials and energy, we need to redesign not only the built-environment, but the nature of development itself!

Development interests in government or industry have therefore, pressured for an ever-increasing supply of raw materials, or promoted increased demand or consumption. This has resulted in a growing throughput of materials and energy. The concept of efficiency has largely been limited to profit instead of reduced resource input. The traditional approach of trying to fix, set caps on, or slow the rate of resource and energy use by regulation is difficult to implement in a capitalistic democracy, as producers, decision makers, consumers and voters, generally oppose limits on consumption. The construction industry's role is central to land, resource and energy consumption. The scale and nature of environmental impacts attributable to CO2 emissions in primary industries depends on how the construction sector is organised, the form of urban settlements, and the materials and energy resources used by buildings. Landscape designers are often hired after construction to enhance the visual backdrop of a building and sculptors are commissioned to add symbols of prestige to a development. Urban planning and design has treated the impact of cities on the hinterland and environment as mere externalities. We must promote consumer accountability by promoting green alternatives; make environmental systems visible, internalise costs of development and help the transition from a fossil-based economy to a carbohydrate-based human ecology.

Ecological Design Principles

1. Solutions grow from place: Ecological design begins with the intimate knowledge of a particular place.
2. Trace the environmental impacts of existing or proposed designs.
3. By working with natural processes we respect the needs of all species while meeting our own.
4. Listen to every voice in the design process flow and the special knowledge that such person brings.
5. Making natural processes visible brings the environment back

to life.

6. Insist on rights of humanity and nature to co- exist in a healthy, supportive, diverse and sustainable condition.
7. Expand design considerations to recognizing even distant effects.
8. Create safe objects of life- term value.
9. Eliminate the concept of waste.
10. Rely on natural energy flows.
11. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.
12. Seek constant improvement by the sharing of knowledge.

Eco-Efficiency Checklist

1. Reduce material intensity of goods and services.
   - Are there less material intensive raw materials?
   - Can the product or service be combined with others to reduce overall material intensity?
   - Can the product be reused, or recycled?
2. Reduce energy intensity of goods and services.
   - Can energy be exchanged between processes?
   - Can waste heat be utilised?
   - Can transport be reduced or greater use made of energy – efficient transport such as rail?
3. Reduce toxic dispersion.
   - Can toxic dispersion be reduced or eliminated by using alternative raw materials or producing them differently?
   - Can any remaining harmful substances be recycled or incinerated?
4. Enhance materials re-cyclability.
   - Can products be made of fewer or marked and easily recyclable materials?
   - Can products be designed for easy disassembly?
   - Can energy be recovered from end-of-life products?
5. Maximise sustainable use of renewable resources.
   - Can more use be made of resources that are certified as being sustainably produced?
   - Are new buildings and refurbishments maximising use of passive heating and cooling?
6. Extend product durability.
   - Can maintenance of the product be improved?

   - Can customers be educated or informed about ways of extending product durability?
7. Increase the service intensity of goods and services.
   - Can customer's disposal problems be eliminated by providing a take-back service?

Can production be localised to both enhance service and reduce transport

Ecological Foot Print of the Built Environment

Current patterns of design are wasteful of non- renewable resources, create toxic materials, and bye- products, require excessive energy for production, harm biodiversity at the source of extraction, and often involve energy – intensive harmful long- distance transport. Estimates of impact of the built environment on nature are as follows: Buildings alone account for one quarter of the world's wood harvest;

a) Buildings consume 1/6th of freshwater supplies;
b) Buildings contribute 25 % to 48 % carbon dioxide emissions;
c) Buildings account for 1/3rd to ½ of total green house gas emissions in developed nations;
d) Construction industry uses 20 to 60 % of total energy consumption in different countries
e) Buildings account for over 40 % of the world's total energy and raw materials consumption
f) Building waste accounts for 44% of landfill and 50% of packaging waste in industrial nations,

Because of faulty design people have to spend more on defensive expenditure on health, safety etc. Landscape designs often demand wasteful watering systems and introduce feral plants while failing to provide local people local food sources and food for non- human beings. At the end of product life, more costs are incurred in landfills that consume valuable space and leach toxins into ground water.

Even Innovations Need to Change

Material and energy consumption in developed countries need to be reduced by 90 % in the next 40 years, if we are to meet human needs equitably within the earth's carrying capacity. Today's R and D is geared to assume innovation to occur within the constraints of a linear industrial system. R and D investment is directed towards spurring economic growth through resource exploitation and consumption.

Even when innovation is linked to eco- efficiency its value appears to lie in the survival of business, rather than human health and well- being. Priority should be given to innovations that target wasteful and polluting processes and products or reduce material and energy flows. For designers it is necessary to go beyond "reduce, reuse and recycle" to "radical resource reduction".

The other requirements of new design strategy are :

a) Bio-mimicry to eliminate waste and toxicity
b) Service and flow economy – meeting customer needs and not creating new wants
c) Investing in natural capital to restore eco- systems and nature's services.

Public education that promotes economics in energy and materials use needs to be promoted

Human Ecology Design : Checklist

Criteria	Essential Qualities
Genius Loci	The spirit of place, Voice of the land, local history;
Landscape	Pattern of Spatial relationship, Location on maps and plans
Elements	Physical features, Climate and weather
Biotics	Life and its supporting systems, Habitats and toxins
Community	Social control, Group and Community processes, institutions, Power
Population	Numbers of species present
Organism	Living or non- living entities, health and function issues, basic needs
Eco- cycles	Cycles of matter, energy efficiency, technology, pollution
Connectivity	Linkages, communications, transport
Time	Change over time, life cycles, learning systems, continuous improvement
Catalysts	Positive and negative feedback, SWOT analysis, Ownership, Implementation
Unspecified	Any special project themes

Industrial Ecology

The global scale of Industry implies that the existing architecture of the Industrial System is obsolete. Industrial ecology is the emerging response to this challenge. It sets out systemic design principles for harmonious co- existence of the industrial system and the natural system.Nature is a cyclic system. International economy can be designed as continuous cyclic flow of materials. Germany is the first country to begin seriously experimenting with the legislation needed to create a cyclic economy.The best known example of an eco- industrial park is in Denmark. It involves co-operation between an electric power plant, a plasterboard factory, an oil refinery, a biotechnology production plant, a sulphuric acid producer, cement producers, local agriculture and horticulture and district heating. Waste of one becomes the raw material of the next. In developed nations Dematerialization, less use of energy and material is happening. De-carbonization, i.e. moving away from high carbon fuels to low ones is also happening. Cyclic flow of materials may suffer from leaks. This problem can be solved by designing differently.

Philosophic Base of Eco-design

Social justice and non-violence, biological and cultural diversity, democracy and participatory decision-making and non-competitive, non-hierarchical forms of social organisation are accepted as preconditions of a sustainable society.

There has been a gradual convergence of ecology, feminism and socialism in green thought. Instead of a Rational Man and Consumer Sovereignty, a relational concept of humanity is developed stressing interdependence of community and nature and emphasizing altruism, empathy and caring. Individual is seen as a caring entity rather than a claimant of rights. Creative design thinking can avoid trade-offs between rich and poor and nature and society. Environmental management has traditionally concerned itself with issues that lend themselves to “hard” measurable, dispassionate methodologies. There has been now increasing attention to developing life quality indicators that look at outcomes rather than outputs.

Responsible Design

If building upon the foundations of eco-philosophy is the first step, redefining design is the second step making eco- logical design. At the very least, designers should ensure that the long- term social and ecological costs of products or developments are internalised, rather than passed on to third parties, the poor or future generations. For example, Urban development should always reduce demand for conventional infrastructure systems (transport, sewage, water and food supply).

Such design strategies include "design for disassembly", design for reuse and design for long- life. A multiple of software is now available to help designers eliminate the life cycle impacts of design decisions. Ecological design can help improve the health of humans and other flora and fauna. It can help reintegrate social and natural world, restoring physical and psychological health.

Ecological design can be "hard tech" or "nuts and bolts", like hyper-car or "soft tech" or "nuts and berries" such as perma-culture. Ecological design is diverted toward a vision for a better future. This process involves determining needs and priorities through participatory planning and design processes and encouraging clients and communities to rethinking end – uses, functions or services required to meet their needs. Buildings, landscapes and urban areas as a whole should provide their own eco- system services, use only renewable or reusable materials, supply their own energy and water on site.

The Sustainable Landscape

Landscapes can be seen as the matrix within which the structures and processes of modernity and post modernity operate, and as a potential form-giver and catalyst for a paradigm of sustainability. New holistic perspectives emerging from fields as diverse as physics, economics and philosophy provide useful insights and methodologies through which the relationship between people and nature may be restructured.

A Sustainable landscape design should

a. Respond to original sources of inspiration;
b. Respond to the site, the unfolding of ecological potential;
c. Minimise inputs;

d. Maximise resilience;
e. Create a place
f. Make systems visible;
g. Minimize maintenance.

The design should catalyse a general shift towards sustainability :

Through integrating art and ecology; Mitigating negative environmental impacts; Enabling opportunities for green product and services; facilitate a multi-disciplinary, participatory design framework.

Urban Buildings: Eco-Design Considerations

1. Broader social and environment context
   - Consider including public uses – childcare facilities, galleries and restaurants
   - Minimize dependency on urban infrastructure
   - Reduce existing urban wind tunnels through building form;
   - Consider design for crime prevention, and provide for environmental education tours.
2. Transportation and global warming
   - Encourage tele- commuting to reduce transport
   - Accommodate public transport
3. Contact with nature in urban areas
   - Provide outdoor open space, seating and plazas
   - Encourage food production on site (roofs, balconies, atria)
   - Provide for vermiculture
   - Create micro- habitats of flora and fauna
   - Use solar landscaping – trees for shading and ponds / fountains for cooling
4. Floor planning and layout
   - Locate services (Wires, ducts) in the floor for easy access;
   - Screen the sun in hot areas with storage, lifts, and corridors.
   - Ensure lighting fixtures are easy to access.
5. Day light and employee comfort
   - Maximize natural lighting in the interior;
   - Ensure cross- ventilation
   - Avoid glaze and heat from windows
   - Design ceiling for both acoustics and absorption of heat
6. Air quality and health

- Reduce or avoid air- conditioning by cool air intake
- Avoid hazardous materials
- Reduce noise amplifications through wall and ceiling articulation, materials etc.
- Ensure air intake is not near kitchens, congested streets and garbage areas

7. Resource and materials conservation
    - Design for rooftop rain water harvesting
    - Develop a system for collecting, storing and distributing surface water run- off.
    - Treat grey water with organic systems
    - Basement may be used for organic waste treatment
    - Reuse materials from buildings demolished nearby
    - Design for durability
8. Timber Usage
    - Avoid rainforest timbers and native forest timbers
    - Wood can only be used from sustainably managed plantations,
    - Use woodless timbers (Hemp, bamboo)
    - Minimum timber waste and plant trees
9. Energy and Heat Conservation
    - Take into account local climate
    - Consider co- generation; use passive solar heating and cooling technologies;
    - Use insulation serving many functions (heat, noise)
10. Technology
    - Design for future upgrading and downsizing of mechanical equipment;
    - Consider smart windows that shade automatically and generate electricity;
    - Use photovoltaic cells that are integral to the roof or walls to generate electricity.
11. Construction process
    - Demand minimum packaging of products delivered to the site; use contracting systems where incentives can be given for eco- solutions.
    - Ensure comprehensive waste management and safety plan
    - Ensure energy conservation measures are checked and fine – tuned after use.

Urban Ecology

Urban areas occupy only 2 % the world's land surface, they use 75 % of the world's resources and release a similar percentage of global wastes.

By looking at the city as a whole and by analyzing pathways along with energy, materials and pollutants move, it is essential to conceive management and technology to increase efficiency of resource use and recycling.

It is necessary to mimic circular metabolism of natural systems. Grey water can be used for urban irrigation.

More ecologically advanced treatment processes use micro-organisms and plants to detoxify sewage.

Urban ecology helps us to generate information relevant to functioning of ecological and human systems and to create responses which are holistic.

The Human responses must incorporate a sound understanding of the functions of eco- systems.

Waste Reduction Check List

1. Has a culture of resource efficiency been developed in your operation? Are sub- contractors and suppliers aware and involved in your waste minimisation plan?
2. Do you have reward system that benefits waste- smart staff?
3. Have you developed waste minimisation performance indicators?
4. Do you have a suitable record- keeping system to monitor and assess performance?
5. Are all key office and site personnel involved in your waste reduction planning?
6. Do suppliers and sub- contractors know what is required of them?
7. Have you developed policies and procedures for separating waste material on site?
8. Are trees and native vegetation retained to fullest extent?
9. Do you retain top soil for reuse on the site?
10. Are erosion and sedimentation controls in place before excavation? Are these controls checked regularly and after heavy storms to ensure they remain effective?
11. Do you use materials produced locally?

12. Do you maximize prefabrication which reduces site waste?
13. Do you specify and or purchase recycled products where possible?

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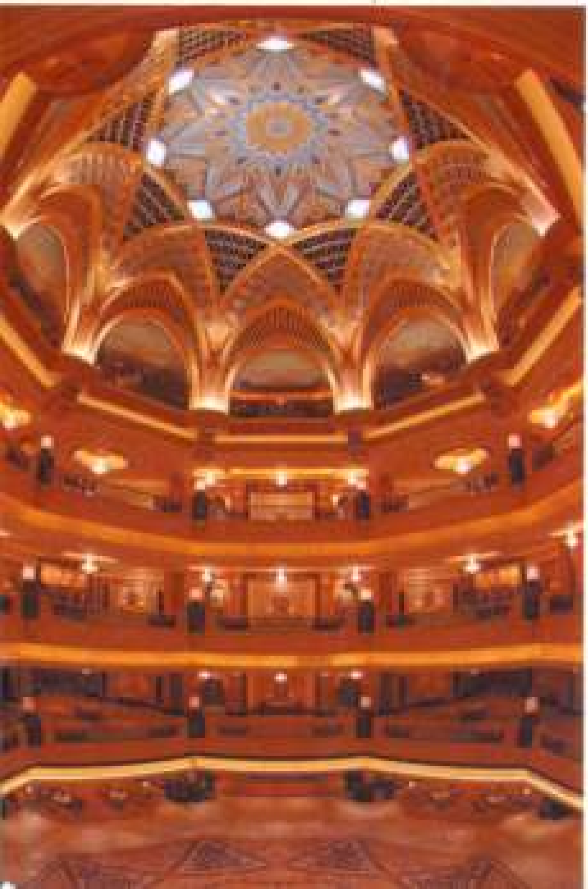
Prakash Gole



Front Cover :
Top : Torrent Research Centre : External view of the air exhaust shafts (Reference : Mere Wala Green)
Bottom : Meera Bapat residence (Reference : Heritage Preservation And Environment Protection)

Back Cover :
Top : Torrent Research Centre : Air inlet view from the concourse showing mist through the sunlight
Bottom : Artificial light and ventilation