Session 7

[Thursday 2nd period 1.5 hours - Main Hall]

Wood in architecture: what can be done? (continued)

Speakers

Speaker:
Ederson Augusto Zanetti

Topic:
Wood From Sustainable Sources and the Mitigation of Global Climate Change – Case Study of Social Interest Housing in Curitiba, Parana, Southern Brazil

Speaker:
Emmanuel Appiah-Kubi

Topic:
Wood for Housing in Ghana: Why the Low Interest?

Speaker:
Roshan Shetty

Topic:
Vernacular Architecture for Sustainable Development - A Case Study of South Canara Region

Speaker:
Neelam Manjunath

Topic:
Saga of the Poor Man's Timber

Wood From Sustainable Sources and the Mitigation of Global Climate Change – Case Study of Social Interest Housing in Curitiba, Parana, Southern Brazil

Ederson Augusto Zanetti[1] and Casagrande E[2]

Abstract

Global climate change is a natural phenomenon being accelerated by human actions that generate Greenhouse Gases - with GHG levels increasing, especially CO2. Amongst sectors which can contribute to reducing emissions by 2030, the construction and forest sectors have significant advantages: the first holds the largest contribution potential while the second the fastest response to an increase on Certified Emissions Reductions - CERs prices, together they can play a major role on reducing the global climate change acceleration. In Parana state, the sector produces almost 35 million m3 / year (57% energy, 43% industrial), corresponding to 8% of GDP, creating up to 750,000 direct and indirect jobs. The government initiated the Program for Timber Productive Sector of Parana State - PFM100, which is responsible of planning the next 100 years of developments within the sector. The main goal of the program is to overcome possible barriers to and support implementing strategic policies to increase the production and use of industrial wood within the state. Located at the South of Brazil, the state holds a current deficit of 314,200 popular homes, and Curitiba, the State's capital, holds a deficit of 50,000 homes. In order to estimate the contribution of increasing wood usage within popular homes, a comparative study was conducted, involving a 52 m2 model traditionally built by the Parana State Housing Company - COHAPAR and an alternative model from the Wood Products Laboratory of the Brazilian Forest Service - LPF/SFB. The LPF/SFB wood house model uses 62 construction items, being 56% of which wood materials, against 67 items applied at COHAPAR model with 29% steel materials. The LPF/SFB model resulted in an emissions reduction of 12,1 tCO2eq / unit just by replacing high emission's associated raw materials, it elevates demand of forest biomass in circa of 60 % and generate another 8 tCO2eq / unit for energy production with the use of solid residues. Besides those effects, the use of residues avoids methane emissions at landfills. In terms of CERs, the cumulative effect of increasing Sustainable Forest Management production or reforestation, replacing raw materials, producing energy from residues and avoiding methane emissions from landfills, result in estimated 83 tCO2eq / unit, or US$ 830 in terms of carbon credits. A list of regional occurring species was elaborated, confronting raw materials for LPF/SFB wood framed house model, resulting on 25 species for being used at State level and 16 species recommended for use at Curitiba area.

Keywords: GHG, carbon, construction, forest, wood, emissions reduction

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1. INTRODUCTION

The Green Economy emerges as an alternative for sustainable consumption habit promotion. The concept involves production and service chains that avoid, minimize, control and compensate environmental impacts from atmospheric pollution, liquid effluents and solid residues.

Global climate change is a natural phenomenon being accelerated by human actions that generate Greenhouse Gases - with levels increasing, especially CO2. Because of this human influence, the United Nations Framework Convention on Climate Change – UNFCCC has contributed to the creation of mechanisms for emissions compensation around the globe. Amongst sectors which can contribute to reducing emissions by 2030, the construction sector is a large GHG contributor, with 30-40% of all global emissions - while the forest sector could give a fast response to an increase in Certified Emissions Reductions - CERs prices. Together they can play a major role on reducing the global climate change acceleration. When addressing the issue of wood framed houses as replacements for traditional cement-iron, there are positive impacts also on the energy and residues sector.

Trees sequester carbon while they are growing and keep it within wood for different periods of time, depending on its end use. Used in construction, the carbon may remain stored in wood for over hundreds of years, while increased reforestation may result in even greater benefits through absorption of CO2. In fact, the area planted with trees can further take out more of it from the atmosphere. Furthermore, using wood to replace emission-intensive raw materials, such as cement and iron, might increase the greenhouse mitigation potential of wood products. The combined effects of using solid residues of production process for energy and increasing yields at forest stands further enhance the social, environmental and social benefits of using wood in construction.

Wood is an adequate alternative for construction, it is a renewable raw material, well adaptable to framing process – dry and quick assembling features (reducing in circa of 30 % the construction time span), has a good weight to mechanical resistance ratio, it can be immediately placed at structures, is a light and environmental friendly option when compared to other building items. However, despite all those comparative advantages, wood is still little used at construction. The main reason for this apparent resistance against wood include lack of tradition on this kind of construction, lack of knowledge from professionals involved in construction about the material and its qualities and, lack of Research & Development – R&D driven to technologies capable of meeting population expectations and needs. There is a noticeable lack of good projects for wood building systems which can offer functional and technological quality. Research into that has covered, among others, monitoring quality of construction process and thermal and acoustic comfort evaluation. Modular constructions can increase versatility and feasibility of this alternative construction for the whole population. Besides all the previous, wood produces residues along production chain and those can be further used or placed for energy production.

Traceability and certification are important issues surrounding the use of wood within construction as a strategy to fight global climate change, just as much as the need to improve technologies to improve application and enlarge life spam of such raw materials. It works towards a system for supporting legal accountability of forest resources and follow its products along the production chain. When the wood can then be audited at any step of the production chain and at any given moment, supplying technical, legal and tenure data and information, it can be used to reduce overall contribution of land use change to carbon emissions. The proportion of the carbon in the logs that ends up in finished products and residues depends on various factors such as species, site conditions, harvesting technique, log grading and efficiency of conversion in wood processing plants. It is important to understand the flows of carbon from harvested logs into different residues (bark, sawdust, off cuts, shavings) and product streams. Different product groups have different service lives, with domestic house framing typically having long service lives. Disposal is a critical stage in the life-cycle of forest products, in terms of their ultimate greenhouse impact. The methods for estimating parameters for accounting the carbon along the production chain may include factors based on national industry averages of volume of forest products manufactured and fate of the products after disposal.

Forest certification is a form of assuring environmental, social and economical compliance of forest products and services, and there are national certification schemes are present at several countries (ITTO, 2008). In Brazil it is covered by the Brazilian Program of Forest Certification – CERFLOR, developed within the framework of the Brazilian System of Conformity Analysis – SBAC. CERFLOR aims to certify "good" forest management practices in both exotic and native stands; it is managed by the National Institute of Measuring and Industrial Quality – INMETRO, and associated with the Program for Endorsement of Forest Certification Schemes - PEFC.

Brazil has a large forest resource base from both natural and introduced species. The large natural grown stock of hardwoods results in products typically long-lived. It is possible to maintain, or even increase, the volume of carbon stored within living biomass while increasing the level of carbon stored within wood products, by adoption of sustainable management practices. Large consumption of industrial wood favor forest cover increase at country level (FAO, 2007), and yield gains at forest sites are result of silvicultural treatments implementation towards production intensification (Nilsson, 2007), Using forest products intensively and extensively practicing Sustainable Forest Management increase the average volume of a forest stand and annual yields. For the recognition of wood material role to mitigate global climate change, efforts are being made to include the so called Harvested Wood Products – HWP. The IPCC has coordinated discussions on potential accounting approaches and methods for estimating carbon in forest products (UNFCCC, 2011) as long as Sustainable Forest Management certified practices are adopted (UNFCCC, 2009). Voluntary markets long-lived wood products carbon accounting involve 100 years life cycle traceability (CCX, 2009).

2. CASE STUDY – SOCIAL INTEREST HOUSES

The Construction sector worldwide invests over US$ 3 trillion / year, employs 111 million people - 90% on micro firms (less than 10 persons) and 75% in developing countries (UNEP, 2009). Around 2025, the world will demand another 11,5 billion m2 of space for residences, 6 billion m2 for industries and 5,4 billion m2 for commerce. In the UNECE region (56 states in Europe, the Commonwealth of Independent States (CIS) and North America), buildings are responsible for over a third of total energy consumption; by and large in the residential sector (20-30% of total final energy consumption on average). Demographic, economic and cultural changes will only increase the pressure of housing on energy consumption and will be accompanied by even higher levels of GHG emissions. On the other hand, evidence suggests that it is the buildings sector and, particularly, the residential sector that could generate some of the greatest energy savings. Using wood is an essential part of this savings, especially for low income populations. On the planet, 70 to 75 % of the population, circa of 4 billion people, live with less than US$ 3,000 yearly, moving US$ 5 trillion. In Brazil there is a deficit of close to 8 million homes – 84% of low income, and demand for another 27 million new units until 2025, while the sector investments will grow from today's US$ 97 billion to over US$ 263 billion in 2030.

In Brazil the forest sector is robust, generating around US$ 20 billion / year on revenues, with US$ 9,3 billion exports in 2008, close to 6 million ha of plantations and 1,6 million directed created jobs (Rochadelli et al, 2008). In Parana state, the sector produces almost 35 million m3 / year (57% used for energy, 43% industrial), corresponding to 8% of GDP, creating up to 750,000 direct and indirect jobs. The Parana state government initiated the Program for Timber Productive Sector of Parana State, which is responsible of planning the next 100 years of developments within the sector. The main goal of the program is to overcome possible barriers to and support implementing strategic policies to increase the production and use of industrial wood within the state.

At wood housing, both small and large scale, righteous species choice (preference for local ones for lowering transport costs), technological developments (preservation, fungicides etc), environmental constrains (Wind, Sun, rain etc), applications - use recommendations (maintenance), building project (detailed) and skillfulness on handling Wood materials are essential for a good project (Chesnost, 2008). New products and technologies contribute to increase applicability of this raw material, be it by durability increase (anti-fungi treatments, anti-insect treatments, water absorption increments etc), be it by enlarging co-products and sub-products generation with high technological inversion (wood oils, cellulosic ethanol, liquid Wood etc).

In Brazil, non-renewable raw materials consumption at construction alone is estimated at 2 t / year / person (Estuqui Filho, 2006. For producing 1 m^3 of aluminum 6,3 tCO_2eq are emitted, while steel production generates 8,1 tCO_2eq for each m^3 ; timber sequestrates at least 0,3 tCO_2eq for producing 1 m^3. For being transformed into finished products, timber uses 2800 GJ, cement 4800 GJ and steel 6700 GJ (Estuqui Filho, 2006). In Australia, house framing on steel generates emissions of 2,7 tCO_2eq against 0,4 tCO_2eq for same structure on wood (FI, 2009). In France, accounting for HWP carbon can generate over US$ 200 million / year (Chesnost, 2008). Construction use of HWP contributes with three major effects to mitigate climate change: carbon sequestration (by trees); direct effect on replacement of high emissions associated raw materials and; indirect effects of replacing those materials. Raw materials manufacturing for houses using more Wood requires less energy, produces less GHG, allows recovering and use of residues from logs, primary and secondary processing, at construction and demolition sites, which together result on a larger production of energy than what gets spent along the production chain. With this, using HWP at construction creates carbon sequestration at wood framed houses (Gustavsson, 2005).

The Green Office (Escritório Verde) at Federal Technological University of Paraná - UTFPR is a model for integrated solutions for sustainable construction. It is an enterprise-School on socioenvironmental management and sustainable construction systems, aiming at construction Certification. The office itself is a model for sustainable and certified building, and the future headquarters of Curitiba's Regional Center of Expertise Integration for Sustainable Development Education (CRIE) (EV, 2011).

2.1 Objective

In Brazil, total social interest housing déficit is of 8 million units. In Parana State, located at the South of Brazil, there is a current deficit of 314,200 popular homes, and Curitiba, the State's capital, holds a deficit of 50,000 homes. This paper examines the total mitigation potential of wood framed houses in substitution of conventional houses used in Curitiba, Parana, Brazil. It also estimates overall impact at production chain.

2.2 Material

The comparative study is performed involving conventional house model, of 52 m2, regularly build by state construction company (Companhia de Habitação do Paraná – COHAPAR), identified as "house type R1 and R1A – CF52", and the alternative Wood model build by Forest Products Laboratory of Ministry of Environment (Laboratório de Produtos Florestais do Ministério do Meio Ambiente – LPF/MMA), called "popular housing in wood", also with 52 m2.

2.3 Method

In order to estimate the contribution of increasing wood usage within popular homes, a comparative study was conducted, involving a 52 m2 model traditionally built by the Parana State Housing Company - COHAPAR and an alternative model from the Wood Products Laboratory of the Brazilian Forest Service - LPF/SFB. The first step was to acquire primary data from raw materials used for building both models and, secondary data on emissions factors and carbon contents of those raw materials from literature (Annex 1).

For performing the study, material's list from both house models were obtained and emissions associated with each construction material were calculated using the total of raw material multiplied by an emission factor, specific to each of them. After this it was possible to obtain the potential of emissions reduction associated with material replacement. The next step was to evaluate which amongst the existing forestry carbon methodologies could be used to expand the estimate of direct and indirect effects of replacing high emissions associated raw materials by wood. Identified routes of estimating carbon mitigation potential were applied to obtain the total potential contribution of this kind of initiative to contribute for reducing emissions for the construction sector.

By analyzing each raw material applied contribution to generate GHG emissions, each model performance in terms of carbon was established. Another task performed was to estimate, based on raw materials volumes and emissions factors, the impact of using more wood along social interest housing's production chain. Both residues and yields could be approached and the final result is an inference on carbon benefits generated along the whole production chain of social interest housing construction.

3. RESULTS

The first result obtained was the raw materials list, being 67 items used at COHAPAR model and 62 items in LPF/MMA. Iron products were the main material. Wood materials are the most important ones at LPF/MMA model, answering for 56% of the list, while COHAPAR model has Iron at the top of the list, with 29% participation, in terms of items. LPF/MMA model also reduces appliance of other materials as ceramics, and sandpaper, besides using less bricks, both resulting on lower emissions associated and higher carbon sequestration potential per built unit.

Raw materials were grouped according with its natural resource origin into Wood, Iron, Sand, Ceramic, Cement, Paint, Stones and Others. Each group is associated to a specific emission factor, which made it possible to obtain the total emissions associated and the carbon sequestrated at each model, as well as its impacts along production chains.

COHAPAR's 52 m2 model, applies to total amount of 5.8 m3 of HWP, while LPF/MMA model uses 9.2 m3 which represents an increase of more than 50%. Due mainly to that, stored carbon, by unit, is 1,7 tCO2eq larger at LPF/MMA model. By lowering energetic demand along the production chain, the total emissions associated reduction is of 10,4 tCO2eq / unit, when using LPF/MMA model. Altogether, circa of 12,1 tCO2eq / unit are reduced by changing to Wood framed houses. LPF/MMA model emitted 2,5 tCO2eq / unit (and stored 4,6 tCO2eq / unit) while COHAPAR had 12,9 tCO2eq / unit of emissions (and stored 2,9 tCO2eq / unit).

Global benefits of using wood at construction related to climate change are associated with carbon stocks of forests and HWP, reduction of emissions from fossil fuels by enlarging biomass availability (including residues) and inducing productivity. Considering the whole HWP production chain, the use of LFP/MAA model generates a demand of 24.4 m3 / unit only from forestry biomass. This will result on an increasing level of reforestation within the region, improving overall carbon stocks of 58,9 tCO2eq / unit. It is also reasonable to expect further improvements on alternative fuels production, since wood production chains generate residues that can be easily used for producing energy. Even after the lifetime spam is over.

By applying social interest housing technical proposal within LPF/MMA model, besides reducing emissions from replacing raw materials, there will be larger availability of wood residues for renewable energy production, resulting from primary and second processing of 17,1 m3 of logs. When those wood residues are used for producing renewable energy, they do not go to landfills, avoiding methane emission that would result from its deterioration, saving 11,4 tCO2eq .

The LPF/SFB model generated another 0,6 tCO2eq / unit emissions saving for energy production with the use of solid residues. In terms of credits, the cumulative effect of increasing Sustainable Forest Management production or reforestation, replacing raw materials, producing energy from residues and avoiding methane emissions from landfills, result in estimated 83 tCO2eq / unit, or US$ 830 per house in terms of carbon credits.

A study, involving wood framing, steel framing and COHAPAR social interest houses with 41 m2 resulted on 2,1 tCO2eq for the first, 3,9 tCO2eq for the second and 7,8 tCO2eq for cement-iron model (Kobiski et al, 2011).

3.1 Tree biodiversity

For establishing a silvicultural program that can supply locally raw material demand for social housing, an exercise was performing, involving studying regional species which can be used for building those houses. A list of regional occurring species was elaborated, based on previous research done at the overall Parana state and Curitiba and Metropolitan Region

(Parana State Capital). That list was compared with the raw materials list for the LPF/MMA wood framed house model, resulting on 25 species for being used at State level and 16 species recommended for use in the Curitiba area.

This study was performed considering forest biodiversity at regional scale, by applying different species according with material destination within the wood house model. Using this approach, for Parana state's regions 1 and 2 (Center-South of the country – 99 municipalities with the lowest income in the state), the listed species included Pinus sp and Eucalyptus sp and other 23 native tree species (Annex 2), while in Curitiba besides the two introduced ones, 14 other species could be applied (Annex 3). Most of them are grown in agroforestry and silvipasture systems, and this project aims at increasing their plantation area within the region, taking advantage of pasture and degradated areas surrounding municipality.

By implementing diversified Forest resource base and foreseen the use of those trees as industrial raw materials suppliers for construction of social interest houses, forest plantations are directed to biodiversity cultivation, emissions' reduction, economical development and social integration. This requires a massive inclusion of local and global actors. The issue of fire has to be addressed, to include fire combat planning for each house unit and condominium, according with governmental and bank regulations. This will increase assurance and secure people's investments as well.

4. MITIGATION POTENTIAL

Brazil, Russia, India and China are growing economically, and consequently this leads to increase their contribution to carbon emissions. Alternative fuels, especially wood biomass, can play an important role to lower those countries emission's rates. In order to balance and trade carbon within the BRIC region, as well as many other services provided by agro ecosystems (water quantity and quality, soil conservation etc), those countries can collaborate to establish a regional forest product and services working group, studying ways for benefiting their economies, environment and society. The global market on forest products reached US$ 207 billion in 2007, and it is expected to surplus US$ 270 billion by 2030. Global production of wood, in 2010, is estimated to be 5.7 billion m3, from this total 75% should be produced in Asia, North America and Europe, being 1.9 billion m3 of industrial round wood and 2.2 billion m3 of wood energy. Latin America on its turn is estimated to produce just 19% while Africa for only 4%. Europe and North America concentrate the production of industrial round wood while the developing regions (Africa and Latin America) concentrate the wood production for energy proposes. There are large deficits of industrial round wood in North America (close to 200 million m3 / year) and Asia (around 50 million m3 / year), with moderate deficit in Europe; Africa has a small surplus and the Latin America region large volumes (over 200 million m3 / year) available for international trade (FAO, 2007).

In Parana state there is a forestry strategy for the next 100 years. Towards it the state shall promote, by organizing seminars and training and offering technical assistance, the increase of municipalities' awareness regarding the necessity of planting forest for industrial wood production. By using a larger number of species within the social interest houses building process, and linking the silviculture program with the state and municipalities demand for those houses, it allows a virtuous cycle involving forest plantations and industrial wood consumption, contributing to lower the overall state ecological footprint.

HWP present a large potential for mitigating global climate change effects in Brazil, with further contribution for reducing national emissions, by reducing their increasing consumption from Land Use Change emissions (Grêt-Regamey et al, 2008). For HWP, requirements are based on the necessity of tracing products from source to final disposal – there are large uncertainty amongst wood materials deterioration periods at landfills, which implicates on GHG emissions and losing of permanence characteristics. Nevertheless, residues recycling for producing alternative energy also generates carbon credits, considering as the baseline fossil fuel emissions and applying an average value for Power generation from biomass residues (Perez-Garcia, 2008). Since 2003, many countries have been elaborating over mechanism adoption by producing and consuming societies should implement to avoid illegal harvesting and trade. This initiative is called FLEGT – Forest Law Enforcement and Governance at Trade, and it foresees voluntary adoption of countries in order to show their political commitment with solving this problem.

Under the UNFCCC, parties report the carbon sequestered by forests in their national greenhouse gas inventories, if they have the required data. The use of sustainably-harvested wood in construction results in several benefits to the society, economy and environment. It is essential now to obtain public recognition for the long-term storage of carbon in forest products by adopting traceability, certification and life cycle assessment approach to the process. Adopting these practices will give recognition to the role of forest products in mitigating greenhouse emissions, and consequently further promote the use of forest products in the country and the overall image of the sector globally.

Sustainable Originated Wood Utilization Network – RUMOS ("RUMOS" in Portuguese means "Directions"), is a proposal for an institutional effort, involving several Brazilian organizations. The aim is to inform the public about the social, economical and environmental benefits of using wood. Its objectives are aligned with similar initiatives in the planet (Annex 4). By integrating forestry from different countries around the objective of promoting wood as form of reducing global climate change effects, the sector provides the basis for increasing public awareness of the benefits of using this raw material. Furthermore, by integrating wood promotion networks, there is an appropriate forum for discussions and coordination of a global system for accounting and certifying forestry carbon, bringing the sector to a new level of participation at international agreements, increasing the strength and influence of its common proposals and positioning.

4.1 BRIC

In 2003, Goldman Sachs' associates published a research report that first coined the term "BRIC economies", referring to Brazil, Russia, India and China can become the largest spenders in the planet, with the highest growth rates (Armijo, 2007). With their growing economies, BRIC countries are expected to reduce poverty and increase consumption levels, turning the region into a very interesting trade partner on the coming years. Within this context, forestry sector can play an important role once a favourable business environment is generated.

Each BRIC country has its own legislation regarding to the utilization of its forest resources. Thus, In order to provide adequate conditions for taking advantage of their regional forest characteristics it is necessary to make adjustments that can contribute in such way that lead to an increase its forestry sector more competitive.

Ministry of Environment – MMA, Ministry of Agriculture, Pasture and Supply – MAPA and Brazilian Forest Service – SFB, are the main responsible for the forest sector in Brazil. In Russia, Ministry of Natural Resources – MNR and the Federal Forest Service – FFS assume that role, while in India the Ministry of Environment and Forests – MoEF, the State and Federal Forest Service – FS, administrate country's forest policy. In China, the State Forest Administration – SFA, is the main institution working within the forest sector at the national level.

Brazil follows the Tarapoto System of SFM practices and the forest management and wood products can get certified either by Forest Certification System Project for Endorsement of Forest Certification schemes - CERFLOR/PEFC or by the Forest Stewardship Council – FSC. Russia follows Montreal principles for Sustainable Forest Management of forest resources, and the Russian National Council for Forest Certification is also recognized by PEFC, making both, the RNCFC/PEFC and FSC certification available at the country. India follows International Tropical Timber Organization - ITTO Process and the national forest certification system by the Program for Endorsement of Forest Certification schemes – PEFC (PEFC, 2008) and FSC (WWF INDIA, 2008). China is a country that follows the Montreal Process for SFM practices, and the Federal Government already established a national system for forest certification, recognized by PEFC as well as the Sustainable Forest Initiative – SFI and the FSC.

Russian National Council for Forest Certification, recognized by the PEFC system, has the largest requirements, with 280 indicators, the China Forest Certification Council, also recognized by PEFC system, ranks second with 112 indicators. Brazil Forest Certification – CERFLOR, recognized by PEFC system, demands compliance with 87 indicators and Bophal India System, recognized by PEFC, is based on 48 criteria of Sustainable Forest Management.

4.2 Harmonization

Harmonization is legally understood as cooperation between governments to make laws more uniform and coherent, making them able to facilitate free trade and protect citizens. Steps to achieve integration start by clear statement of country's local issues and a joint process of developing mutually agreed initiatives at regional scale.

The unilateral actions of developing National Forest Programs – NFP, can be integrated into a BRIC Forest Plan, which considers local potential and synergies between countries to guide a regional process of turning this into environmental, social and economical benefits. Eventually it could be issued a BRIC Certification Systems allied to a regional carbon trade system. The aim is to capture local forest sector characteristics and work with them into a regional forum, resulting on an integrated proposal of joint action into global markets. It should be discussed a harmonization of BRIC's forest legislation in order to make its forest sector more competitive at the international market.

BRIC countries can gain a lot from developing a harmonized Forest Certification System, starting from the relevance it will have on influencing all other systems within the region and including acceptance as an international standard, recognition of equivalence between all forest certification schemes within the region, further promoting and tiding regional cooperation, produce standards with an inclusive approach based on bottom-up decision making process and unilateral recognition of their scheme, which enhances the potential of negotiating as a block in other agreements.

Governments should look for ways to recognize the role of mutual recognized forest certification schemes and make the process of obtaining them easier to comply with, especially from the producing country's side. Certification schemes should not be forced to compete but rather supported on taking advantage of their similarities to coordinate efforts into the direction of consolidating their role for sustainable trade development.

Montreal Process, adopted by both Russia and China, presents a level of compliance of almost 60% with the ITTO System of India, and 40% with the Tarapoto System, making the Brazilian efforts into direction of harmonization the most needed. Areas of C&I considered at the comparison included Biological Diversity, NTFP, Forest Related Services, Soil and Water Conservation, Social and Cultural Aspects and Values, Forest Employment, Forest Ownership and Policy and Institutional Frame Conditions (Rametsteiner, 2006).

By building and consolidating a process of harmonizing their certification systems, BRIC countries provide the necessary tools for accessing carbon credits markets at global scale. Sustainable forest management operations, harvested wood products and residues recycling have larger opportunities at both regulatory and voluntary markets when already certified by third parties. BRIC countries can position themselves to assimilate global climate change effects and fight poverty together, by proposing fresh and joint ways of mitigating its effects towards their forest sectors, presenting a cost-effective solution fit for the region's shape.

5. CONCLUSIONS

It was observed a highly positive impact of replacing conventional cement house model by an alternative wood concept. Only on raw material used at each unit, carbon savings of 12,1 tCO2eq. Besides that, it was possible to identify further carbon mitigation benefits along the production chain, including increasing forest productivity (sequestration), supplying biomass (residues) for alternative fuels production and lowering emission from residues disposal and those associated with the use of high emissions related raw materials (cement, iron, bricks etc).

All together, each unit generate around 83 tCO2eq considering the baseline of keeping the conventional cement model. . LPF/MMA model emitted 2,5 tCO_2eq / unit (and stored 4,6 tCO_2eq / unit) while COHAPAR had 12,9 tCO_2eq / unit of emissions (and stored 2,9 tCO_2eq / unit).

To further promote wood production and consumption for Green Economy competitiveness gain, harmonization of BRIC countries forest legislation and SFM C&I are suggested. This could enforce traceability, certification and carbon credits generation and trade.

6. REFERENCES

Armijo L.E, 2007. The BRICs Countries (Brazil, Russia, India, and China) as Analytical Category: Mirage or Insight? Asia Perspective. Vol. 31, No. 4. Pp 7-42.

Asian Developmnent Bank. 2008. Asia Economic Monitor – AEM. December edition. Available at: http://aric.adb.org/asia-economic-monitor/ on 05/01/2008. 76 pgs. Hong Kong, China.

Chesnost, C, 2008. Review of Current Accounting Rules for the Forestry Sector: Inclusion of Carbon Sequestration in Harvested Wood Products (HWP). Ernest & Young Paris. Apresentação no Workshop: Harvested Wood Products in the Context of Climate Change Policies. 9-10 de setembro de 2008. Genebra, Suíça. 21 pgs.

Chicago Climate Exchange – CCX. 2009. Long-Lived Wood Products.Access on site: www.chicagoclimatex.com/content.jsf?id=1683 on June, 22nd, 2009. 1 pg. Chicago, USA.

Escritório Verde, 2011. Escritório Verde: Modelo de Construção Sustentável Certificada. Acesso no site: http://www.escritorioverdeonline.com.br/escritorio-verde-modelo-de-edificacao-sustentavel-certificada/ em 10/09/2011. Curitiba, Pr, Brasil. 1pg.

Estuqui Filho, C.A, 2006. A Durabilidade da Madeira na Arquitetura sob a Ação dos Fatores Naturais: Estudo de Caso em Brasília. Msc thesis. Architecture Course of Brasília University. 149 pgs. Brasília, DF, Brazil.

Food and Agriculture Organization of the United Nations (FAO), 2007. State of the World's Forests 2007. Communication Division. ISSN 1020-5705. Roma, Italy. 2007.

FI – Forestry Insights. 2009. Wood to the Rescue. 4 pgs. Acesso no site: http://www.insights.co.nz/rescue.aspx. On Frebruary, 9th, 2009.

Grêt-Regamey, A. , Headrick, E. , Hetsch, S. , Pingoud, K. , Rütter, S, 2008.Challenges and Opportunities of Accounting for Harvested Wood Products. Texto de referência para o Workshop: Harvested Wood Products in the Context of Climate Change Policies. Genebra, Switzerland. 16 pgs.

Gustavsson, L.; Sathre, R. e Pingoud, K, 2005. Greenhouse Gas Benefits of Wood Substitution: Comparing Concrete - and Wood - Framed Buildings in Finland and Sweden. IEA Bioenergy task 38 – Greenhouse Gas Balances of Biomass and Bioenergy Systems. T38:2005:05. Project: oefpbf 05012. Retrived from: http://www.ieabioenergy-task38.org/projects/task38casestudies/finswe-brochure.pdf, on march, 6th, 2009. 06 pgs.

Kobiski, B.V. , Casagrande Jr, E. , Morais, E.G. e Radaskievics, T, 2011. Comparativo de Emissões de Casas de Alvenaria de Interesse Social e Casas Utilizando o Sistema de Construção Energitérmica Sustentável. Publicação do Programa de Pós-graduação em tecnologia. Send to the author by email. UTFPR. 10 pgs. Curitiba, Brasil.

Nilsson, S. 2007. Mobilizing Wood Resources: What's the Big Deal? 2007. Paper for "Mobilizing Wood Resources" workshop, UNECE, Geneva, Switzerland, January 11-12. Acesso on site:

www.unece.org/timber/workshops/2007/wmw/presentations/wood_resources_Nilsson.pdf. Retrieved July, 5, 2009. 33pp.

Perez-Garcia, J, 2008. How Can Certain Forest Lands and Products Participate As an Offset or Other Cap and Trade Program? Presentation Workshop: Harvested Wood Products in the Context of Climate Change Policies. September, 9-10th. Genebra, Switzerland. 43 pgs.

Program for Endorsement for Forest Certification (PEFC), 2008. Council Information Register. Access at: http://register.pefc.cz/statistics.asp em 16/12/2008. 01 pg.

Rametsteiner, E, 2006. Opportunities to Create Synergy Among the C&I Processes Specific to the Topic of Harmonization. Inter-C&I Process Harmonization Workshop. Bialowieza, Poland. Pgs 11-22). Collaboration Among C&I Process – ITTO/FAO/MCPFE. Bialowieza, Poland.

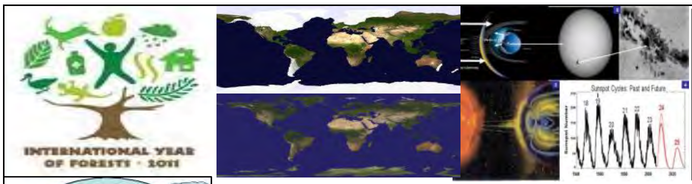
Rochadelli, R. , Garzel, J.C.L.S., Rodrigues, F. , Schneider, A.V. and Petla, D, 2008. Expansao florestal Via Fomento no Segundo Planalto Paranaense: Uma Abordagem a Partir da Estrutura Fundiária das Propriedades Rurais na Região. Revista Cerne – Universidade Federal de Lavras. Access on site: http://redalye.uaemex.mx/redalyc/pdf/744/74414209.pdf on July, 28th, 2009. April-june, vol 14, number 002. Pp 163-169. Lavras, MG, Brasil.

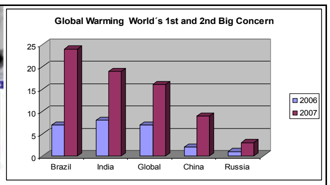
UNEP – United Nations Environmental Program, 2009. SBCI. Sustainable Buildings and Construction Initiative. Access on site: http://www.unepsbci.org/aboutSBCI/Getinvolved/ on July, 28th, 2009. 1 pg.

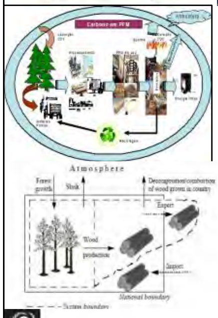
United Nations Framework Convention on Climate Change (UNFCCC), 2009. Ad Hoc Working Group on Further Commitments for Annex I Parties Under the Kyoto Protocol. Seventh session. Bonn, 29 March to 8 April 2009. Item 5 (b) of the provisional agenda Other issues arising from the implementation of the work programme of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol Land use, land-use change and forestry. Bonn, Germany. 12 pgs.

United Nations Framework Convention on Climate Change (UNFCCC), 2011. Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol Sixteenth session. Bangkok, 5–8 April 2011, and Bonn, 6–17 June 2011. Agenda item 3 Consideration of further commitments for Annex I Parties under the Kyoto Protocol. 50 pgs. Bonn, Germany.

World Wildlife Fund India, 2008. Consultative Meeting on Forest Certification in India. Folder announcing the event. Access at: http://assets.wwfindia.org/downloads/forest_certification_meeting__background_1.pdf. em 16/12/2008. 02 pgs.







Sustainable Buildings & Construction Initiative

AJW2011
Rediscovering Wood: The Key to a Sustainable Future

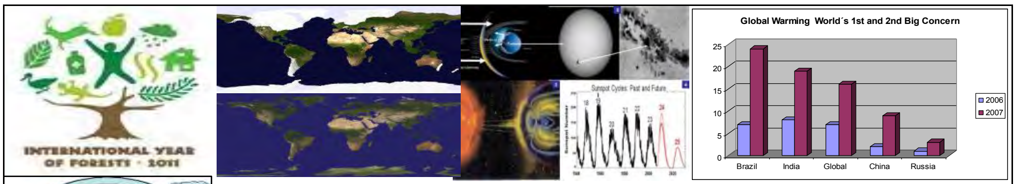
WOOD FROM SUSTAINABLE SOURCES AND THE MITIGATION OF GLOBAL CLIMATE CHANGE – CASE STUDY OF SOCIAL INTEREST HOUSING IN CURITIBA, PARANA, SOUTH OF BRAZIL

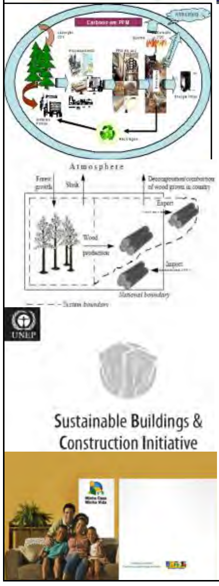
Eder Zanetti
Eloy Casagrande

Bangalore, India
October / 2011

Support and Data

- **FAO**
- UFPR
- UTFPR/PPGTE-PPGEC
- LPF/MMA
- Embafort
- STCP Engenharia de Projetos
- Green Farm CO2FREE



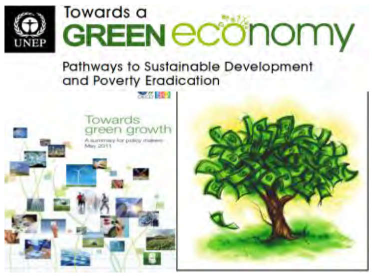


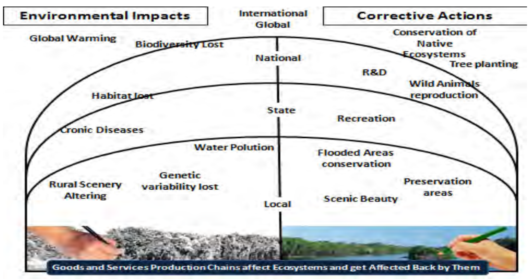
Content:

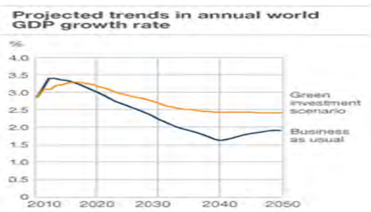
Green Economy and Global Warming
Forest and Construction Sector Emissions Reduction Potential
Wood and Climate Change Mitigation
Comparative Study: Cohapar X LPF/MMA
Curitiba Tree Species Diversity
Forests and Green Economy
Harmonization and Networks for Wood Promotion
Conclusion

Green Economy

- **Production and Consumption of Environmental Goods and Services and Payment for Ecosystem Services**
- **Should became the largest share of international trade by 2050**



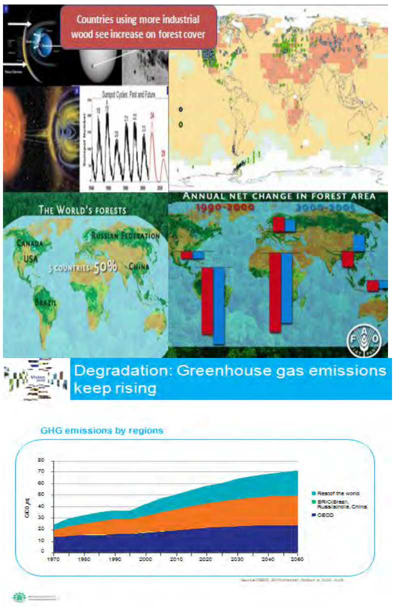




GHG and Forestry

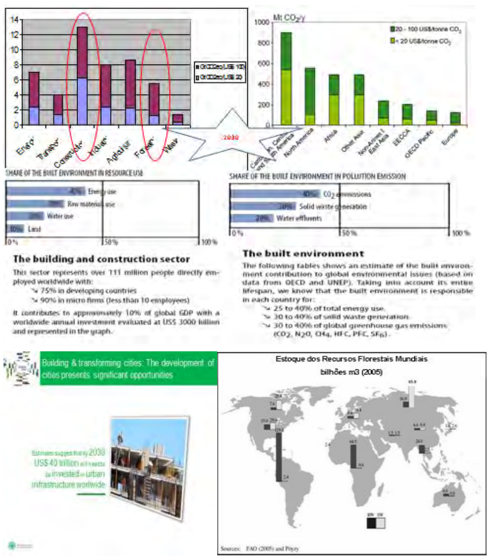
Partially Avoidable with Sustainable Forestry

- Increasing emissions at BRIC countries:
  - Burning of fossil fuels;
  - Disposal of residues;
  - Burning of biomass direct to atmosphere
- Affects Biological and Physical Systems
- Land use change from forestry occurs in countries with low consumption of timber products (high consumption of energy wood)



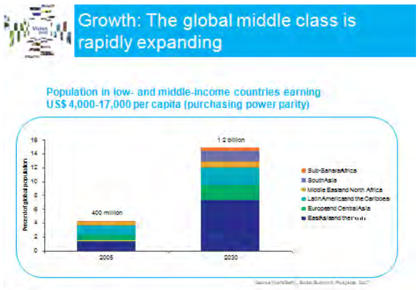
Forest and Construction Sector

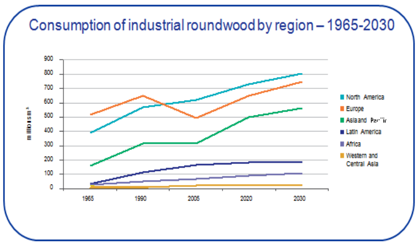
- Forest sector respond faster to an increase on carbon prices;
- Construction sector has the major potential contribution to reduce GHG emissions (2030 scenario by IPCC2007);
- Use of industrial wood in developing countries is reduced – specially in Brazil;
- Construction sector invests US$ 3 trillion / year, employes over 100 million people (75% at developing countries and 95% in companies with less than 10 workers) – social and economical contribution



Wood and Climate Change

- World stocks of wood are increasing – increase on income, increase on industrial wood stocks;
- Transfer of wood from sustainable forest management to industrial products does not implicate on emissions of GHG;
- Use of wood residues for production of energy replaces burning of fossil fuels and reduces emissions from degradation at disposal sites;
- The longest life-spam of products generates largest benefits;
- Brazil tropical hardwoods hold carbon by long periods and the country has the largest world stock of hardwoods





Green Office UTFPR (Escritório Verde)

Integrated Green Construction Solutions

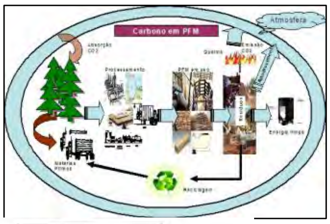
- Biodimate oriented architecture project – Scenery approach
- Green roof (local vegetation in the building at two modules;
- Natural lighting using smart skilight system;
- Termodinamic solar heating system for water and internal environment;
- Ecodesigned furniture;
- Air cooling and umidity control system;
- Use of low environmental impact materials:
  - Gravel draining terrain permeabilization and external flooring from recycled materials
  - Certified internal wood flooring
  - Plastic wood (wood dust + recycled paper)
  - Carpet from recycled material
  - Share of internal walls external covers and furniture on bamboo
- Wood-framed construction using double-packed OSB panel walls;
- Temperature and acoustic isolation with recycled PET and tires;
- Wood-framed windowns and specially developed double glass;
- LED for energy efficiency;
- Solar panels supplying up to 70% of energy consumption (addition of an eletric car charging system under analysis);
- Rain water collection system for sanitary and cleaning appliance with UV treatment;
- Ellevated flooring made from recycled material
- Smart grid systems of logic, automatization and security

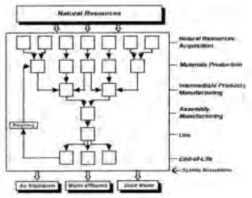
CASAGRANDE, E. (2011)

- Federal Technological University of Paraná - UTFPR
- Carbon Neutral construction at Paraná State
- Enterprise-School on socioenvironmental management and sustainable construction systems
- Certification
- Green Office (Escritório Verde) – Model for sustainable and certified building
- CRIE – Curitiba:
  - Regional Center of Expertise Integration for Sustainable Development Education
  - Member of a 80 similar centers network
  - United Nations University (UNU) approved
  - Responsible for educational projects implementing

Comparative Study I

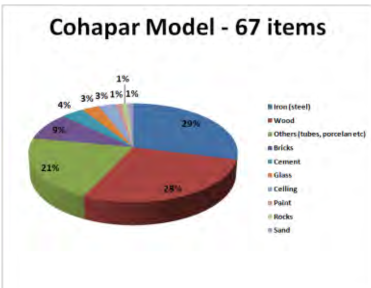
- Production chain carbon estimates of two Social Interest House Units – 52 m2;
  - Paraná State Housing Development Company – COHAPAR and;
  - Wood Products Lab of the Environmental Ministry – LPF/MMA
- Carbon Emissions:
  - Construction materials:
    - Cement; iron (steel); sand; bricks; transportation
- Carbon sequestration and storage:
  - Forests:
    - Above and below ground biomass:
  - Harvested Wood Products:
    - Wood parts:
      - Flooring; doorframes; windownframes etc
  - Residues (negleteable):
    - Recycle:
    - Energy;
    - Landfill

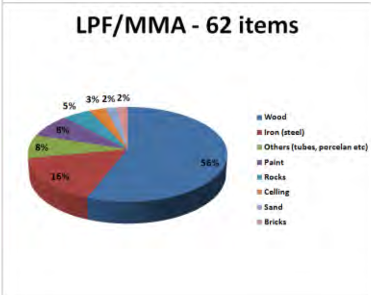




52 m2 Social Interest House

- Combined: 12,1 tCO2eq/unit
  - Less material, less emissions:
    - LPF/MMA: 2,5 tCO2eq
    - Cohapar: 12,9 tCO2eq
  - Wood – larger stock:
    - LPF/MMA: 4,6 tCO2eq
    - Cohapar: 2,9 tCO2eq



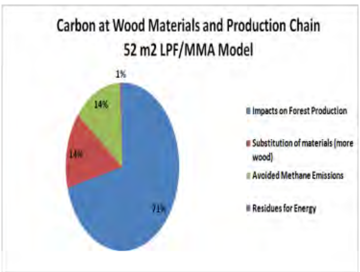


Comparative Study 52 m2 Social Interest Houses
Carbon of Wood Materials and Production Chain

		Wood materials			Production chain		
Item	Description	m3	GHG emissions (tCO2eq)	Carbon sequestration (tCO2seq)	wood (m3)	log (m3)	Biomass (m3)
LPF/MMA	wood	[illegible]	2,5	4,6	13,1	32,8	65,6
COHAPAR	Cement X Iron	[illegible]	12,9	2,9	8,2	20,6	41,1
Balance		3,4	-10,4	[illegible]	4,9	12,2	24,5

Production Chain Environmental Impacts

- Impacts on Forest Production:
  - Wood from Sustainable Sources;
  - Transference of biomass to wood products allows increase of carbon sequestration and storage with same area
- Substitution of Materials (more wood):
  - Replacing materials with high associated GHG emissions;
  - Increase production of residues of biomass along production chain
- Avoided Methane Emissions:
  - Keeping residues for being displace at landfill;
- Residues for Energy:
  - Substitution of fossil fuel burning



LPF/MMA 52 m2 Social Interest Houses						
Carbon of Wood Materials and Production Chain						
	tCO2eq					
Item	Impacts on Forest Production	Substitution of materials (more wood)	Avoided Methane Emissions	Residues for Energy	Total	US$ (10/tCO2eq)
Unit of 52 m2	58,9	12,1	11,4	0,6	83	830

Comparative Study II – Framed Houses

Production chain carbon estimates of two Social Interest House Units – 41 m2;

- **Paraná State Housing Development Company – COHAPAR and;**
- **Wood Products Private companies**

Carbon Emissions:

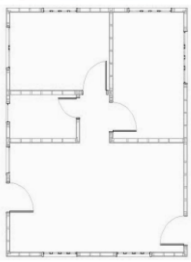
- **Construction materials:**
  - **Cement; iron (steel); sand; bricks; transportation**

Tabela 1 - Comparativo de Emissões

Emissão de CO_2 (kg)			
DESCRIÇÃO DOS SUBSISTEMAS	COHAPAR	STEEL FRAMING	WOOD FRAMING
FUNDAÇÃO	1.293	1161	1.161
ESTRUTURA PRINCIPAL	914,6	1.354,5	0,00
VEDAÇÕES EXTERNAS	1483	91,68	91,68
VEDAÇÕES INTERNAS	2878	99,78	99,78
FORRO DE PVC	197,5	197,5	197,5
COBERTURA	1.021	1.021	580,2
EMISSÃO DE CO_2	7.787,75	3.925,25	2.129,81
REDUÇÃO	-	50%	73%

Fonte: O autor (2011)

COHAPAR

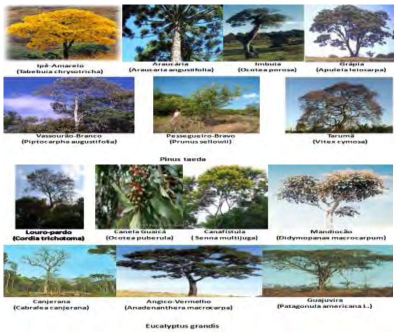


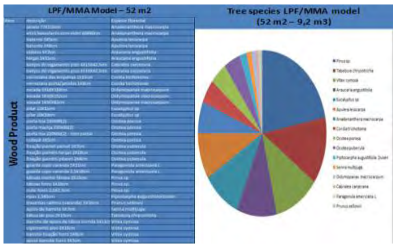
Wood Framing

Kobiski et al, 2011

Curitiba Tree Species Diversity for Wood House

- Natural and introduced species for industrial wood production;
- Use according with silvicultural and mechanical characteristics:
  - Cutting Cycle;
  - Density;
  - Workability;
  - Life-spam;
- Commercial value of wood products at regional markets

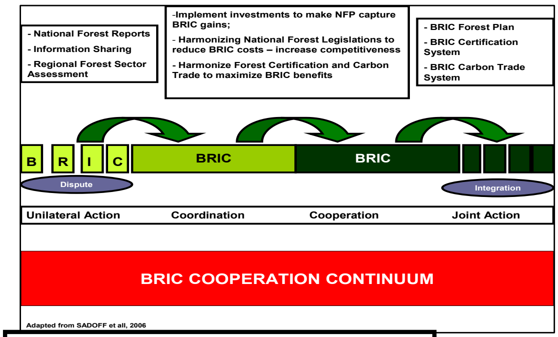


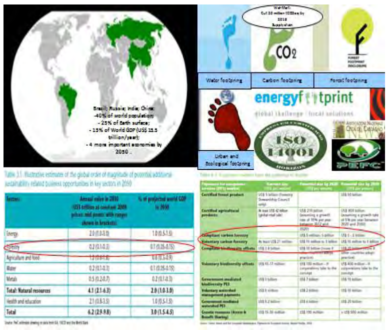


Forests and Green Economy

- Action Plan (UNECE):
- 1. Production and Consumptuion of Wood from Sustainable Sources
- 2. Low Carbon forest sector
- 3. Green Jobs at forest sector
- 4. Evaluation and PES from forests
- 5. Forest sector governance and monitoring

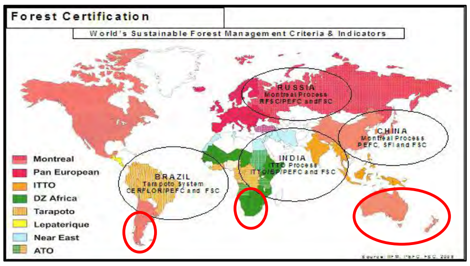
BRIC WOOD NETWORK
Step towards a Global Wood Network (+ UNECE+Mercosul)





- Mutual recognition and block transactions increasing
- Increase overall stocks of wood products
- Implement measures to account for trade on products and services:

  Ecosystem Services
- Global Wood Networkcreation



World Wood Culture

Wood for a Better Planet Initiative - WBPI

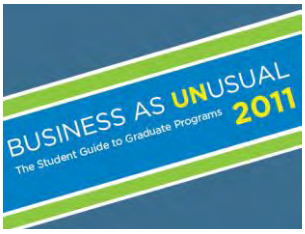
Wood for a Healthier Planet Initiative - WHPI

Wood for the World Initiative - WWIWood for the World Initiative - WWI

Conclusion

- **Wood from sustainable sources hold strong potential for reducing global warming and poverty:**
  - Construction
  - Forestry
- **Wood production and consumption cope with Green Economy:**
  - Income generation
  - Job creation
- **Major opportunities for BRICS (South Africa) countries:**
  - Network for promoting wood production and consumption
  - Harmonizing SFM C&I

Lahtvee, 2011



Thank you!

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Wood for Housing in Ghana: Why the Low Interest?

Emmanuel Appiah-Kubi and Stephen Tekpetey[3]

Abstract

Timber, a renewable natural resource, has structural, non-structural and decorative advantages as a housing material. In Ghana, the use of timber for the construction of houses has faced many challenges in recent years. Existing timber houses constructed tens of years ago and are still standing, attest to timber's durability and its potential as a housing material. The call and desire for housing construction using timber has not been realized. This paper therefore reviews and highlights the reasons why there is low interest in the use of timber for housing in Ghana. Interviews and semi-structured questionnaires were administered to the general public, timber processing firms and timber-constructed households. Data were analysed using a descriptive statistical method. Overexploitation of timber in reserves, lack of design and detailing, and the inadequate expertise and skilled tradesmen in the timber construction industry are some of the technical reasons that account for the low patronage of timber for housing in Ghana. The public indicated some psychological reasons such as timber would be consumed easily by fire, and wood's susceptibility to insect attack and decay. There is also the perception that wooden houses are for the poor and those who cannot afford other materials such as concrete and steel. More research needs to be conducted to enhance the use of timber in housing through efficient processing methods, increased value-addition to wood products and advanced techniques in the timber housing industry. More expertise and skill tradesmen in timber construction need to be trained. Education and sensitization of the general public on accepting wood as a housing material needs to be promoted.

Keywords: wood, housing, low, interest, construction

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1. INTRODUCTION

Timber is one of Ghana's most readily available natural resources. The natural forest resources occupy an area of some 81,306 square kilometers, approximately one-third of the entire country and hold more than 400 indigenous hardwood species (Anon, 1996; Usher and Ocloo, 1979). In spite of the abundance of this natural resource very little of it is used structurally for construction in Ghana due to the prejudice against its use and lack of technical data on its properties such as strength and durability of most of the species, especially the lesser known ones.

Timber is a structurally sound material and compares favourably with concrete, steel, and stone and a variety of other materials in terms of strength per unit mass. Timber in its natural state can be used for many forms of construction (Jayanetti, 1998). As a construction material, wood is strong, light, durable, and flexible and easily worked with. In contrast to the substitutes for wood in structural purposes such as brick, metal, concrete and plastics, wood can be transported with little energy consumed and its resource is completely renewable (Koch, 1991). It can be produced from sustainably managed forests to achieve both economic and environmental benefits. It has high resistance to heat flow, that is, it is a good insulator and has low thermal capacity. These characteristics make it an inherently suitable material for building in hot humid climates like Ghana. Like both steel and concrete, timber can provide attractive buildings and greater durability and also design structures of almost any size with it.

In recent times, timber houses have been regarded as old fashioned and face replacement by other modern materials. Interest in using timber as a housing material has dwindled and is now almost inexistent. It is very difficult to locate a house built principally of timber or a house built with about 70% of materials being timber. Timber is at best used for roofing and ceilings, and also for making doors and windows in a building. There is therefore a low interest in using timber as a principal material for housing in Ghana. There are several factors accounting for this low interest in building with timber. Baiden et al. (2005) explored the key barriers inhibiting the use and potential of timber for housing construction in Ghana. They classified the barriers into two categories: technical and psychological barriers. The technical barriers included the absence of skilled tradesmen, lack of design and detailing by architects and engineers, the dwindling timber resource and the ineffective treatment of timber. Psychological barriers such as the fear of possible damage by insects and fungi and destruction by fire came up as a result of some of the technical barriers which had not been resolved. However, continued research into the efficient processing and utilization of Ghana's timber resource and the promotion of lesser known and lesser utilized species continue to address some of these challenges. Efficient treatment and preservation methods for different species of wood are available to ensure durability and resistance of wood members to insect and fungal attack in their service life. Available data on mechanical and machining properties of various species provide consultants in the construction industry with design properties for design and detailing. In spite of these interventions, the interest of the general public in building houses with timber is still very low. The current study therefore seeks to determine the reasons why interest in building with timber in Ghana is low after these interventions.

2. MATERIALS AND METHODS

The study was conducted in the Kumasi Metropolis in the Ashanti region of Ghana. The Kumasi Metropolis has a large number of timber processing firms and also has significant number of timber-constructed houses which were built decades ago and are still occupied.

Two hundred (200) members of the general public were randomly selected. Interviews were conducted at the timber processing firms, and also for personnel (architects, engineers) in the industry. Semi-structured questionnaires were administered to the general public some of which lived in timber-constructed households. The questionnaires sought to find out whether respondents had seen a timber house before or not and their opinions on using timber for the construction of their houses. Information gathered during the interview and questionnaire administration included reasons for not using timber and recommendation on timber housing. Data were analysed using a descriptive statistical method.

3. RESULTS AND DISCUSSIONS

3.1 Responses from General Public and Timber constructed households

Sixty-five percent (65%) of the respondents indicated that they have seen a timber house before as compared to about 35% who had not. The state of timber houses as identified by those who indicated to have seen a timber house is shown in Figure 1. It was observed that, of those who agreed to have seen a timber house, 55% described the state of the houses to be in a fair state, 25% judged them to be in a good state and 20% described the state of the buildings to be poor (Figure 5).

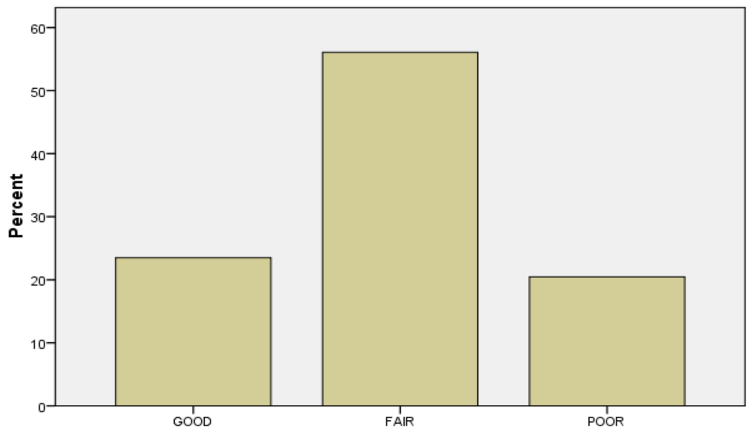

Figure 1: The state of timber houses seen by respondents

Out of the 200 respondents, only 22% had lived in a timber house compared to 78% who had never stayed in a timber house. Of those who lived in a timber a house, it was observed from Figure 2 that, about 38% of the respondents have stayed in timber houses for about 11 to 20 years. 30% had stayed in for about 1 to 5 years and 15% for more than 20 years. Only 5% of the total respondents had stayed in timber houses for just below 1 year.

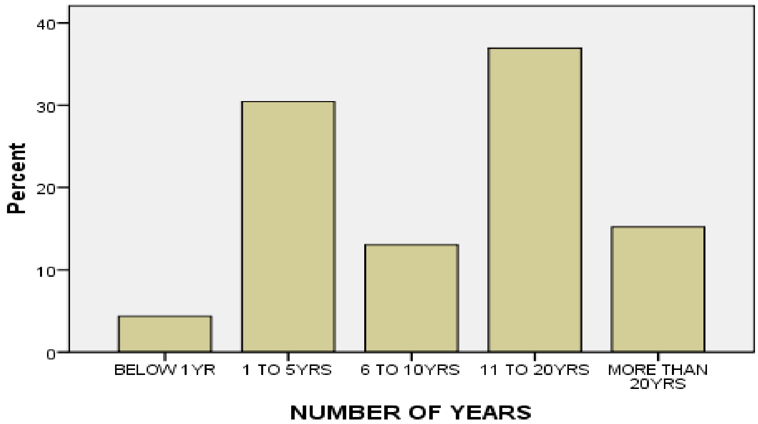

Figure 2: The number of years respondents had stayed in a timber house

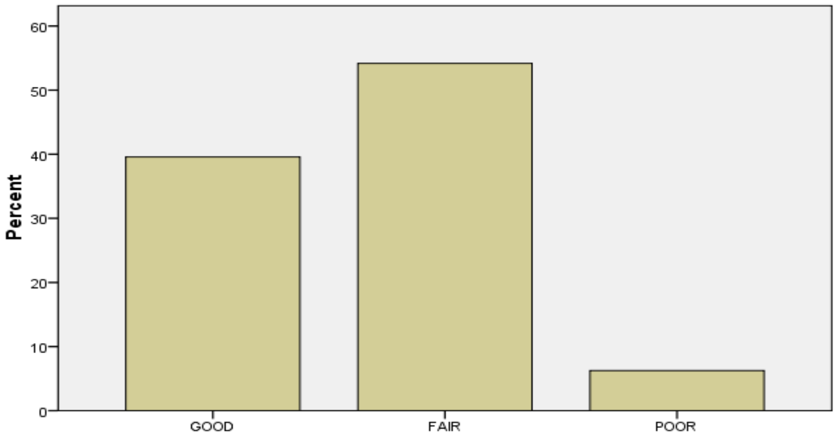

Figure 3: The condition of timber houses respondents are occupying

Further analysis of the data revealed that 55% of the respondents who lived in a timber house described the condition of the building to be in a fair state as shown in Figure 3. Forty per cent (40%) of the respondents described the buildings to be in a good state and the remaining 5% described the building to be in a poor condition. It can therefore be concluded that, most of the existing timber buildings in the Kumasi metropolis are in a fair condition.

Figure 4: A timber house in a good state

Figure 5: A timber house in a poor state

Table 1: Respondents reasons for not using timber for housing

Reasons	Frequency	Percentage out of 116 respondents (%)
Easily consumed by fire	105	91
Very costly	70	60
Not readily available	80	70
Easy break through by thieves	95	82
Susceptibility to insect attack and decay	94	81
Timber houses are for the poor	62	53
Timber houses are for those who cannot afford other materials such as concrete and steel	79	68
Serious destruction by flood as compared to blocks or bricks houses	97	84
Difficulty in acquiring lumber	87	75

Out of the 200 respondents 116 (58%) indicated that they would not consider building their houses with wood or live in house built with wood. Several reasons were given for this decision. 91% of them said they would not build their houses with wood because it is easily consumed by fire. Over 80% of the respondents indicated reasons such wood is susceptible to insect attack and decay, faces serious destruction by flood compared to brick or block houses, and its safety. There was 75% indication that there is difficulty in acquiring wood for construction so one would bother about building with wood. This reason supports earlier findings by Appiah-Kubi et al (2011) that local carpenters do not obtain their wood from sawmills because of the bureaucracies associated with obtaining wood from the mills. Some respondents (53%) also believe that timber houses are for the poor and so do not want to dream of building with timber. Most of the timber structures in Ghana are not aesthetically pleasing compared to the magnificent concrete and steel structures.

Table 2: Reasons for using timber for housing

Reasons	Frequency	Percentage out of 84 respondents (%)
Readily available	58	69
Hot or Cold weather does not affect timber frame housing	67	80
Less costly	59	70
Provides good ventilation	77	92

Out of the 200 respondents, 84 of them (42%) indicated their interest in building their house with wood. They gave several reasons for the decision. Ninety-two percent (92%) of respondents indicated that wood provides good ventilation, 80% indication that hot or cold weather does not affect timber frame housing and 69% indication that wood is readily available and less costly. In 2005, only 17% of the 200 respondents according to Baiden et al. (2005) would recommend timber housing in Ghana and indicated reasons such as it was attractive (42%), faster to build (29%) and easy to work with (29%). The reasons indicated by the public in this current study means that the public is gradually getting to understand the properties of wood as a material.

Baiden et al (2005) established that about 83% of the public would not live in timber houses. Even though the gap between the two has narrowed over the years through interventions (research and promotion), there is still a considerable majority of people who would not live in a wooden house or build their house with wood for the reasons aforementioned.

3.2 Responses from technical personnel

Interviews conducted at the wood processing firms in the metropolis indicated that, almost all the firms do not supply the local market (carpenters) with wood because of reasons such as the high cost of production, the demand from the export market and the need to get foreign exchange. The majority of wood used domestically in Ghana is obtained from illegal sources (chain-sawn lumber). The timber processing firms (saw millers) therefore do not encourage the use of wood for domestic housing in order not to put pressure on the dwindling wood resource.

The availability of information on physical, mechanical and machining properties of wood species in Ghana has not influenced the choice of architects and engineers in material selection during design. They still design and build in concrete and steel, with glass and plastics for furnishings. Wood is mainly used for roofing, ceiling, making doors and windows in construction. There is inadequate training in the design and detailing of timber structures hence the capacity gaps in building with timber. Very little is taught in Timber Engineering in Ghanaian educational institutions to promote efficient utilization of wood hence the lack of expertise in the timber construction industry.

It was observed that foresters in Ghana do not encourage local housing with wood because of the overexploitation of timber in reserves by illegal operators for domestic needs.

4. CONCLUSIONS AND RECOMMENDATIONS

In spite of wood's many favourable advantages as a housing material, it is not generally being used for housing construction by professionals in that they do not recommend it to clients. Previous study done by Baiden et al. (2005) confirmed that the general public is widely not interested in living or building their houses with wood.

The public indicated some psychological reasons such as timber would be consumed easily by fire, faces serious destruction during flooding and wood's susceptibility to insect attack and decay. There is also the perception that wooden houses are for the poor and those who cannot afford other materials such as concrete and steel. Most of the timber structures in Ghana are not aesthetically pleasing compared to the magnificent concrete and steel structures.

Overexploitation of timber in reserves, lack of design and detailing, and inadequate expertise and skilled tradesmen in the timber construction industry are some of the technical reasons that still remain and account for the low patronage of timber for housing in Ghana. The reasons indicated by the public in this current study means that the public is gradually getting to understand the properties of wood as a material.

It is therefore recommended that more research needs to be conducted to enhance the use of timber in housing through efficient processing methods, increased value-addition to wood products and advanced techniques in the timber housing industry. Furthermore, more expertise and skill tradesmen in timber construction need to be trained. Education and sensitization of the general public on accepting wood as a housing material needs to be promoted. Plantations of fast growing species and the promotion of non-timber forest products (NTFPs) such as bamboo should be intensified to supplement dwindling timber resource. The availability of enough resource would encourage the use of wood for housing.

5. ACKNOWLEDGEMENTS

The authors express their profound gratitude to Joseph Asante, a statistician, for his support in collecting and analysing the data during the study. Many thanks to the Food and Agricultural Organisation (FAO) for providing support to actively participate in an International conference on the Art and Joy of Wood Conference in Bangalore, India.

6. REFERENCES

Anon, 1996, Ghana Forest Development Master Plan 1996-2020, Ministry of Lands and Forestry, Accra, Ghana.

Appiah-Kubi, E, Adom-Asamoah, M, Frimpong-Mensah, K, and Tekpetey, S, L, 2011, Wood processing capacity of sawmills and carpentry workshops in Ghana, Proceedings of the 20th International Wood Machining Seminar (IWMS-20), held at Skelleftea, Sweden, June 7-10, 2011, pp 255-261.

Baiden, B, K, Badu, E, and Menz, F, S, 2005, Exploring the barriers to the use and potential of timber for housing construction in Ghana, Journal of Construction and Building Materials, June 2005, Gale Group, farrington Hills, Michigan.

Jayanetti, D, L, 1998, Lesser-Used Timber Species in Construction, Technical Session V, Timber Engineering and Re-constituted Wood, International Conference on Value-Added Processing and Utilisation of Lesser-Used Timber Species, Forestry Research Institute of Ghana (FORIG), International Timber Trade Organisation (ITTO) and Timber Export Development Bureau (TEDB) Proceedings, pp 145-156.

Koch, P, 1991, Wood as non-wood materials in US residential construction: Some energy related international implications, Working Paper 36, Food and Agricultural Organisation (FAO), Seattle, WA, USA, Centre for International Trade in Forest Products, University of Washington.

Usher, M, B, and Ocloo, J, K, 1979, The natural resistance of Eighty-five West African hardwood timbers to attack by termites and microorganisms, The Tropical Pest Bulletin No.5, Natural Resources Institute, ISBN 10:0851351034, December 1979.

REDISCOVERING WOOD: THE KEY TO A SUSTAINABLE FUTURE
The International Conference and Exhibition on the Art and Joy of Wood
Bangalore, India, 19-22 October 2011

INTERNATIONAL YEAR OF FORESTS · 2011

WOOD FOR HOUSING IN GHANA: WHY THE LOW INTEREST?

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WOOD FOR HOUSING IN GHANA: WHY THE LOW INTEREST?

Emmanuel Appiah-Kubi

OUTLINE OF PRESENTATION

- Introduction
- Objective of the study
- Methodology
- Results and Discussions
- Conclusions
- Recommendations
- Acknowledgements

INTRODUCTION

- Timber, a renewable natural resource, has structural and decorative advantages as a housing material.
- Timber is one of Ghana's readily available natural resource
- Wood can be transported with little energy consumed compared to other materials in structural applications such as brick, metal, concrete (Koch, 1991).
- It has high resistance to heat flow which makes it a suitable material for building in hot humid climates

INTRODUCTION

- Wood in its natural state can be used for many forms of construction (Jayanetti, 1998)





INTRODUCTION

- Existing timber houses are still standing, which attest to timber's durability and its potential as a housing material.
- In recent times, timber houses have been regarded as old fashioned and face replacement by other modern materials – steel, plastics, concrete, glass
- Very little of wood is used structurally for construction in Ghana due to the unfounded prejudice against its use and lack of technical data on its properties such as strength and durability of most of the species, especially the lesser known ones (Usher and Ocloo, 1979).

INTRODUCTION

- Baiden et al (2005) explored the key barriers inhibiting the use and potential of timber for housing in Ghana. They classified the barriers into two;

1. Technical barriers - the absence of skilled tradesmen, lack of design and detailing by architects and engineers, the dwindling timber resource and the ineffective treatment of timber
2. Psychological barriers - the fear of possible damage by insects and fungi and destruction by fire

- Efficient treatment and preservation methods for different species of wood are available to ensure durability and resistance of wood members to insects and fungal attack

OBJECTIVE OF STUDY

- The objective of the study is to determine the reasons why interest in building with wood in Ghana is low.

METHODOLOGY

- The study was conducted in Kumasi in the Ashanti region of Ghana

METHODOLOGY

- Interviews were conducted at the timber processing firms, and also for personnel (architects, engineers) in the construction industry
- Two hundred (200) members of the general public were randomly contacted
- Semi-structured questionnaires were administered and interviews conducted
- Data were analyzed using descriptive statistical methods

RESULTS AND DISCUSSIONS

- 65% of the respondents had seen timber house before whilst 35% who had never seen a timber house their lives

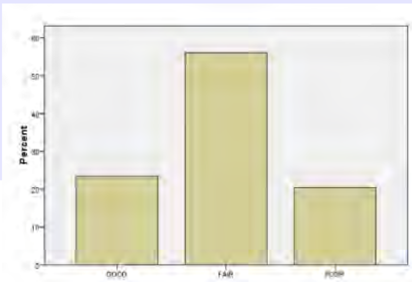


Figure 1: The state of timber houses seen by respondents

- 55% of those who had seen a timber house, described the state of the houses to be in a fair state, 25% judged them to be in a good state and 20% described the state of the buildings to be poor

RESULTS AND DISCUSSIONS

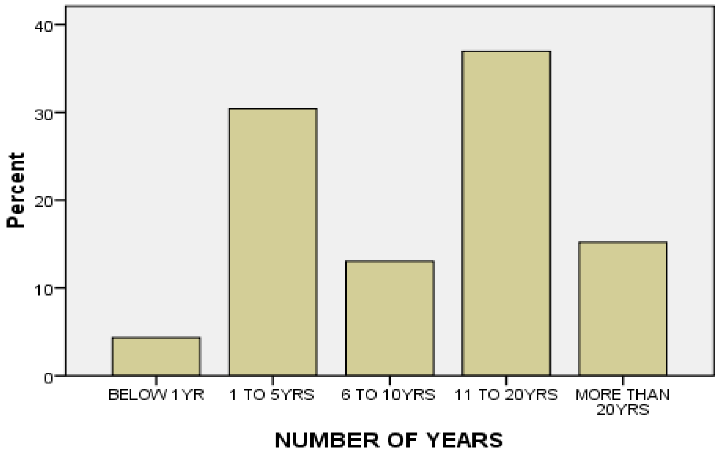
Timber house in a good state

Timber house in a fair state

Timber houses in a poor state

RESULTS AND DISCUSSIONS

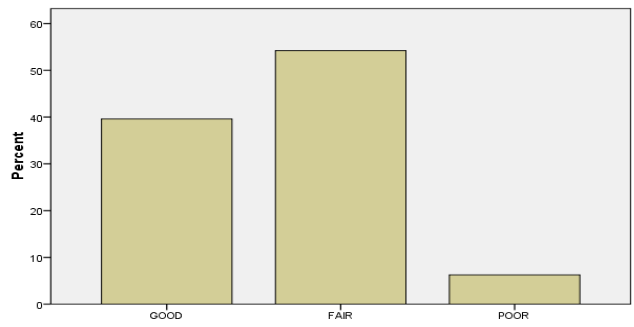
- 22% of the 200 respondents lived in a timber house compared to 78% who had never stayed in a timber house.



The number of years respondents had stayed in a timber house

RESULTS AND DISCUSSIONS

Most of the timber buildings in Kumasi are in their fair conditions



The condition of timber houses respondents are occupying

RESULTS AND DISCUSSIONS

- 58% of the respondents indicated that they would not consider building with wood or live in house built with wood.

Table 1: Reasons for not using timber for housing

Reasons	Frequency	Percentage out of 116 respondents (%)
Easily consumed by fire	105	91
Very costly	70	60
Not readily available	80	70
Easy break through by thieves	95	82
Susceptibility to insect attack and decay	94	81
Timber houses are for the poor	62	53
Timber houses are for those who cannot afford other materials such as concrete and steel	79	68
Serious destruction by flood as compared to blocks or bricks houses	97	84
Difficulty in acquiring lumber	87	75

RESULTS AND DISCUSSIONS

- 42% indicated their interest in building their houses with wood

Table 2: Reasons for using timber for housing

Reasons	Frequency	Percentage out of 84 respondents (%)
Readily available	58	69
Hot or Cold weather does not affect timber frame housing	67	80
Less costly	59	70
Provides good ventilation	77	92

RESULTS AND DISCUSSIONS

- Interviews conducted at the wood processing firms in Kumasi revealed that, almost all the firms do not supply the local market (carpenters) with wood for housing for the following reasons:

1. the high cost of production,
2. demand from the export market
3. the need to get foreign exchange
4. dwindling timber resource

RESULTS AND DISCUSSION

Professional (architects, engineers) interviewed revealed the following reasons:

- There is inadequate training in the design and detailing of timber structures hence the capacity gaps in building with timber in Ghana
- lack of expertise in the timber construction industry.
- the overexploitation of timber in reserves by illegal operators for domestic needs

CONCLUSIONS

- The public indicated some psychological reasons such as the fear that wood can be easily consumed by fire, faces serious destruction during flooding and wood's susceptibility to insect attack and decay

- There is also the perception that wooden houses are for the poor and those who cannot afford other materials such as concrete and steel

CONCLUSIONS

- Overexploitation of timber in reserves, lack of design and detailing, and inadequate expertise and skilled tradesmen in the timber construction industry are some of the technical reasons that still remain and account for the low patronage of timber for housing in Ghana

RECOMMENDATION

- More research needs to be conducted to enhance the use of timber in housing through efficient processing methods, increased value-addition to wood products and advanced techniques in the timber housing industry
- More expertise and skill tradesmen in timber construction need to be trained
- Plantations of fast growing species and the promotion of non-timber forest products (NTFPs) such as bamboo should be intensified to supplement dwindling timber resource
- Education and sensitization of the general public on accepting wood as a housing material needs to be promoted

ACKNOWLEDGEMENTS

- Many thanks to the Food and Agricultural Organization (FAO) for providing financial support and making it possible to present the findings of the study at the Art and Joy of Wood Conference in Bangalore, India

Vernacular Architecture for Sustainable Development - A Case Study of South Canara Region

Roshan Shetty[4] and Shantaram Patil[5]

Abstract

Wood is a historic, classic and durable building material that has long life, good tactile warmth, aesthetics and a natural flair to buildings for thousands of years. Wood has many attributes that make it a smart environmental choice. It is the only major building material that is renewable, recyclable & sustainable over the long term and it is a natural choice when it comes to climate change. Wood has been widely used as a building material in the vernacular architecture. The vernacular architecture in the South Canara region of Karnataka state has evolved over time to reflect the environment, cultural and historic context. These houses were built in response to actual needs using the natural resource wood that is available locally and which fitted well into the environment. It was influenced by a wide range of different aspects of human behaviour and environment, thus leading to different building forms for almost every different context. The building forms were greatly influenced by the lifestyle of the occupants and the way they used their shelters. These houses are the witness of the skills in the workmanship and craftsmanship of ancestors. The restoration and conservation of the vernacular houses, temples, wood crafts and artefacts of the South Canara region is undertaken by the Heritage Village, Hasta Shilpa Foundation, Manipal, South Canara. Understanding the principles of vernacular architecture and learning fundamental lessons from them and adapting these in the contemporary architecture. This paper illustrates how the essence of vernacular architecture can be used to protect the culture and the tradition of wood in the current urban context for a sustainable future. Thus the heritage villages serve as an inspiration for the future posterity and contribute to sustainable development and present new opportunities for development of the wood.

Keywords: wood, vernacular architecture, sustainable development, environment.

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1. INTRODUCTION

It is believed that the vernacular houses in the South Canara region have sustained for more than 4 to 7 centuries. The Vernacular houses were made of predominantly locally available building materials in the region i.e. mud and wood. A wide species of wood like bhogi, jack, teak etc. were extensively used for the construction. The vernacular architecture is climate responsive and is a reflection of the customs and lifestyles of a community. They were environmentally fit and well suited to the surrounding nature. Vernacular Architecture was based on the knowledge of traditional practices and techniques of our ancestors. They were self-built and reveal a high regard for workmanship, craftsmanship and quality.

The vernacular architecture of the South Canara has rich cultural and heritage value. These built forms, which are of region-specific, are a result of centuries of experimentation which are shaped by social, cultural, religious and technological influences. These were continuously refined by trial and error based on the changes in societal characteristics and technology. As a result, these built forms have served their purpose very well, being extremely sustainable and appropriate to their setting and satisfying the functional and aesthetic aspirations of the users. But there has been a rapid change in the built form the last few decades due to growth and the development of the society and thus there has been a drastic change in the past and the present built form. The regional architecture has an incredible potential for influencing the current architectural trends in that region. The various aspects of the heritage dwellings as a special value conveying a specific image, also understanding and interpretation of these as heritage site has been well discussed by Ajai Chandran and Krishne Gowda (2010).

1.1 Wood - A renewable resource

The qualities of wood as a historic, classic and durable building material that has leant longevity, good tactile warmth, aesthetics and a natural flair to buildings for thousands of years has been discussed by Barbara Horwitz-Bennett and C. C. Sullivan (2008). Wood is one of the oldest materials that have been used in the construction and probably the most versatile.

Wood is the only renewable source for building materials. It comes from forests that are continually being replanted as they are harvested. This practice ensures a plentiful supply of wood for construction and for innumerable of other uses. Young forests grow vigorously and store greater quantities of carbon. As trees mature, this rates slows down. Harvesting older trees helps keep the forests young while at the same time locking up carbon in our buildings. From this perspective, it is better to harvest a forest before it is over mature. Sustainable forest management practices ensure that the carbon absorbing properties of the forest are preserved. In addition, energy generation from wood residues like leaves, tree waste etc. reduces the need for fossil fuels.

1.2 Wood as a green building material

Wood is very warm material. Massive wood has a great warmth capacity. That is, there is a lot of accumulating mass. In vernacular houses, wood balances out the temperature changes in different times of day keeping the interior temperature comfortable. In summer the atmosphere is pleasantly calm and in winter smoothly warm. Wood also possesses significant, positive environmental attributes. Wood is the only single major renewable building material, and it also requires less energy to manufacture than any other building material. The selection of environmentally responsible building material is an aspect of sustainable building. Wood is thermally efficient and easy to insulate.

Wood offers advantages in construction applications such as warmth and beauty, flexibility, durability, workability, high strength to weight ratio, good electrical insulation, low thermal conductance and excellent strength at low temperatures. It has high shock absorption capacity. It can be easily bent or moulded to relatively sharp curative. Life Cycle Assessment also demonstrates that the environmental profile of wood offers a clear advantage over other major building materials. Wood structures are also recognized to be among the safest building structures in an earthquake and in areas that face a risk from high winds.

1.3 Wood for sustainable development

"Sustainable development is a development pattern which focuses on efficient resource use to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations to come" as quoted by Brundtland (1987) . Wood restores the carbon dioxide and then purifies the air we breathe. Wood plays a positive role in a healthy ecosystem. It not only adds oxygen into the air but also absorbs the carbon dioxide greenhouse gas we add to the atmosphere through our daily use of energy from fossil fuels. Wood is a naturally perfected building material. Man-made building materials simply add harmful pollutants to our environment in the process of manufacturing, while dynamic nature of a growing forest helps the environment for years before the wood becomes a building material. Using wood for the construction will keeps this natural cycle unbroken and maintains healthy forests, and thus promotes a better environment for earth's inhabitants.

Sustainability is also about maximizing the resources that are locally available so as not to waste, damage or exhaust them. The longevity of buildings makes it even more important to use sustainable construction to maximise the efficiency of the building and the quality of life for future generations. The studies of vernacular Architecture for sustainable development are discussed by Ashwani Kumar and Navneet Munoth (2011).

2. VERNACULAR ARCHITECTURE AS A SUSTAINABLE BUILT FORM

The vernacular houses in the South Canara region of Karnataka comprises of the dwelling as well as other buildings relating to environmental context, using local available materials and utilising traditional technologies, have evolved over time to reflect the environment, cultural and historic context. These houses were built in response to the actual needs using the natural resource wood and fitted well into environment.

It was influenced by a wide range of different aspects of human behaviour and environment, thus leading to different building forms for almost every different context. The houses have various devices that are built into their design promotes the cooling of interior spaces and also facilitate the flow of breeze. The aspects of energy efficiency of vernacular houses and passive cooling measures are discussed in the paper by Anantha Krishna et al. (1993).

The building forms were greatly influenced by the lifestyle of the occupants and the way they used their shelters. These houses are the witness of the skills in the workmanship and craftsmanship of ancestors. The buildings reflected the thoughtful process of the ancestors and the way of their life, culture and tradition. The vernacular architecture was built to meet specific needs of the people, accommodating their values, economies and ways of living of the culture by the people. The materials, construction techniques and various components of Vernacular Architecture are discussed below.

2.1 Materials and construction techniques

Mud and wood, the locally available materials were used for the construction extensively in the region. These materials were used for superstructure in the majority of the buildings. The walls were of mud mortar and were supported on granite foundation (Ref Fig 1). The thickness of the walls ranged from 40 cms to 80 cms in the ground and the upper storey.

The wooden columns and the beams acted as the structural members (Ref Fig 2) and the mud walls also took the load of the roof in some places and acted as barriers in some spaces of the house. The wooden columns are very stout and taper from bottom to top, carrying heavy wooden beams, which in turn support secondary beams, battens and wooden planks.

To prevent warping of the planks, used for false ceiling, a layer of mud is placed over them and finished with mud plaster to a smooth surface. The wooden beams transfer their weight to the columns with the help of the brackets attached to the capital of columns. The wooden columns are placed at close intervals of approximately 2.5 metres to carry load of the roof. The wooden floor and the wooden ceiling consist of battens and planks supported on wooden beams. The extensive use of mud and wood has helped in achieving considerable heat insulation inside the house.

Figure 1: The front elevation of the vernacular house of South Canara

Figure 2: View of the balcony

2.2 Detailing and ornamentation in wood

Wood has been extensively used as a building material. The extensive use of wood, which is an easily workable material, has led to a profusion of detailing and ornamentation in the houses. The houses reflect high order of workmanship and craftsmanship prevalent in the region about centuries ago. The higher the status of the owner of the house the more elaborate are the carvings and decorative features. The massive, heavily carved wood work is supported by heavy wooden column which is beautifully carved shows the workmanship and craftsmanship of the ancestors (Ref Fig 3). The sloping, lean to roof over the front open veranda has many layers of wooden components.

The decorative rafters, which form the bottom most layers, are supported on wooden beams. The wooden planks of 25mm to 50mm thickness are laid out over the rafters and a layer of mud covers these planks and over the mud layer will be another set of rafters. These rafters support wooden battens and mangalore tiles. This method of roofing requires plenty of wood, thus it is very effective in reducing the transmittance of solar radiation absorbed by the roof. An interesting pattern of wood work can also be seen decorating the ceiling in the open veranda also.

Figure 3: Interior view of the vernacular house

Figure 4: The wooden swing seat hung from the wooden ceiling

There are large overhangs of tiled roof which protects the enclosure and external walls. Wooden inverted 'L' shaped brackets are inserted into the wall at an interval of 2.5 meters so as to project about 1.2 meters on the aide of the wall. Wall plates sit on the brackets and the rafters, in turn, are support on the wall plates. On the inner side of the walls is a corridor, which is also covered on an identical overhang. This roofing over the high wall not only serves to protect wall from rain and Sun but also provides a similarity in roof form, with the rest of the house. The wooden swing-seat is also a part of the vernacular house (Ref Fig 4).

2.3 Doors and windows

The window has a solid wooden frame and can be closed on the inside by two heavy shutters, one folding up, and the other down or folding from either side (Ref Fig 5). The lower shutter becomes a window seat, with a pair of legs, hinged in wood, swinging out to support it as it is lowered. The upper shutter is held by wooden catches. Some windows have barred windows, closed internally by sliding panels. The door is smaller in size and has a solid wooden frame around it. The wooden bolts, which also have a locking system, are widely used for securing two leafed doors from inside (Ref Fig 6).

Figure 5: Wooden doors **Figure 6: Wooden bolts**

2.4 Corridors

Most of the corridors on the periphery of the house have wooden frame work form the ground floor to the upper storey. The sloping roofs have large overhangs from the corridor which are supported by the wooden pillars (Ref Fig 7 & 8).

Figure 7 Slender columns in the corridor **Figure 8 View of the corridor**

2.5 Columns and beams

The wooden columns and the beams are the major components of the vernacular houses and acted as the structural members that took the load of the roof. The wooden columns are very stout and taper from bottom to top, carrying heavy wooden beams, which in turn support secondary beams, battens and wooden planks. The massive heavy wooden columns are elaborately carved with decorative features. Not only the columns are beautiful and intricately carved and designed, but also the beams and the struts. Wooden columns and struts are usually carved with geometric and stylized figurative motifs and show the workmanship and craftsmanship of the ancestors (Ref Fig 9 & 10).

Figure 9: Decorative wooden column

Figure 10: View of the heavy and the slender wooden columns

2.6 Staircases

These wooden stairs were used for vertical movement from the ground floor to the upper storey and to the attic. The stairs are a flight of wooden treads and risers between solid wooden side planks (Ref Fig 11 & 12). They are held together by mortice and tenon joints and by wooden peg.

Figure 13 View of the courtyard

Figure 14 View of the wooden ceiling

2.7 Courtyard

A courtyard in the vernacular house is the central open space and used by women for their work and for many other purposes also. Living spaces are organised around the courtyard and are of wooden ceiling. The roof drains into the central area and from there out of the house. Wall motifs of animals are seen in the inner walls of the house. The interior courtyard also acts as a ventilator and illuminator for the interior (Ref Fig 13 & 14).

Figure 11: View of the staircase

Figure 12: The treads are held by planks on either side

3. CONCLUSION

The vernacular architecture is not only to study about the past history, culture and traditions, but also should contribute to the present and future needs of the built form. We should understand, appreciate, preserve, conserve the cultural heritage of the region and also enhance the environmental quality of the vernacular architecture which has been handed over to us for generations from our ancestors.

As wood is a natural perfected building material, it has got various environmental benefits over other man made building materials. One should understand the low impact of the vernacular houses on the environment over the other modern buildings. There is a need to grow more forests, from this there is enough production and supply of wood and wood products for the construction industry. Growing more forests not only helps in supplying the raw materials (wood based products) for construction but also gives us raw material for furniture. Forests also help to protect the land from erosion, strong winds and waves. It helps in absorbing CO2 and supplies O2, thus purifying the atmosphere. This quality of forests also helps sustainable development. We need to ensure that the treasure we have i.e., the forests will be there for our future generations and helps the natural cycle to be intact also.

The design principles and approaches of the vernacular houses should be implemented for the building we design and build. By this the vernacular houses become an essential factor for the sustainable development. Thus these vernacular houses of the region will serve as an inspiration for the future posterity and contribute to sustainable development and present new opportunities for development of the wood. Thus the vernacular houses and the wood provide a sustainable livelihood.

4. REFERENCES

Ajai Chandran, C, K, and Krishne Gowda, 2010, Social Perspective of Heritage Dwellings: A case study of the 'Hirebettu House', Institute of Town Planners, Indian Journal 7 – 4, page number 37 – 44.

Anantha Krishna, K, S, Deshmukh, R, P, and Rewatkar, K, P, 1993, Passive Cooling measures in Vernacular Houses of South Kanara, Proceedings on Energy Efficient Buildings and Building Materials, Cell for Renewable Energy Dissemination activities, Karnataka State Council for Science and Technology, Indian Institute of Science, Bangalore.

Ashwani Kumar and Navneet Munoth, 2011, Vernacular Architecture: A prerequisite for sustainable development, Architecture – Time Space and people, Volume 11, Issue 7.

Barbara Horwitz-Bennett and Sullivan, C, C, 2008, Using wood for sustainable design, Building Design + Construction.

Brundtland, 1987, Report of the World Commission on Environment and Development – our common future, Oxford University Press, Oxford.

Ilay Cooper and Barry Dawson, 1998, Traditional Buildings of India, Thames and Hudson Ltd, London.

Vernacular Architecture for Sustainable Development – A Case Study of South Canara Region

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REDISCOVERING WOOD: THE KEY TO A SUSTAINABLE FUTURE
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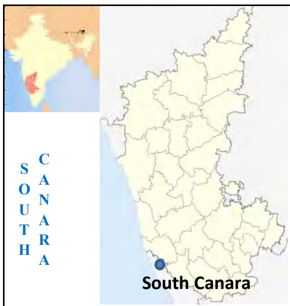

LOCATION / GEOGRAPHY

South Canara is a coastal district in the state of Karnataka. The Arabian Sea bounds it on the west and Western Ghats in the east. Major rivers flows through the region which all join Arabian sea. Vast areas of evergreen forest covers the region, but now has been depleted due to rapid and unplanned urbanization and hectic commercial activities. South Canara has an area 4,866 square kilometres, and a population density of 390 persons per square kilometre. There are 354 villages in the district.

CLIMATE

The climate in Udupi is hot in summers and pretty good in winter. During summers (from March to May) the temperature reaches up to 40 C and in winters (from December to February) it is usually between 32 C and 20 C.

The monsoon period is from June to September with one of the rainfall averaging more than 4000mm every year and heavy winds.

VEGETATION

South Canara is a very beautiful, scenic, and picturesque place, containing lush green vegetation, forests, and fertile crop fields. The Udupi district has thick evergreen forests in the eastern part. They form part of sahyadri or Western Ghats of India. These forests have wide range of flora and fauna. A wide species of wood like Bhogi (Teak), Karmara (Ebony), Wild Jack, jack and many other native trees grow in the region.

Vernacular Houses of South Canara

- Vernacular houses have sustained for more than *4 to 7 centuries.*
- The vernacular architecture of the South Canara has got *rich cultural and heritage* value.
- They were predominantly made of *locally available building materials* i.e. mud & wood.
- A *wide species* of wood like Bhogi (Teak), Karmara (Ebony), Wild Jack, jack and many other native trees were extensively used for the construction of these houses.
- The vernacular architecture is *climate responsive*.
- The houses reflect the *customs and lifestyles* of the community.
- The houses were *environmentally fit* and well suited to the surrounding nature.
- Vernacular Architecture was based on the knowledge of *traditional practices and techniques* of our ancestors. They were self-built and reveal a high regard for *workmanship, craftsmanship and quality*.
- The built forms, which are of region-specific, are a result of centuries of experimentation which are shaped by *social, cultural, religious and technological influences*. These were continuously refined by trial and error based on the changes in societal characteristics and technology.
- The vernacular structures are extremely *sustainable* and are appropriate to their setting and satisfy the *functional and aesthetic* aspirations of the users.

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Vernacular Houses of South Canara

- The houses were *environmentally fit* and well suited to the surrounding nature.
- Vernacular Architecture was based on the knowledge of *traditional practices and techniques* of our ancestors. They were self-built and reveal a high regard for *workmanship, craftsmanship and quality*.
- The built forms, which are of region-specific, are a result of centuries of experimentation which are shaped by *social, cultural, religious and technological influences*. These were continuously refined by trial and error based on the changes in societal characteristics and technology.
- The vernacular structures are extremely *sustainable* and are appropriate to their setting and satisfy the *functional and aesthetic* aspirations of the users.

Vernacular Houses of South Canara

Regions cultural wealth expressed in the form of traditional buildings, objects of art, craft and other artefacts of aesthetic interest, dating several hundred years ago.

Traditional Houses of different community . . .

Kunjur Chowkimane . . . *The Brahmin priests house*
Hungaracutta Bansaale Mane . . . *A trader's house*
Harkur Olaginamane . . . *The Bunt house*
Vaderhobli House . . . *The Bunt house*
Byndoor Nelyadi House . . . *The Bunt house*
Yerukone House . . . *The landlords house*
Hengavalli Korra House . . . *The landlords house*
Bhatkal Muslim House . . . *The muslims house*

K U N J U R   C H O W K I M A N E

Elegant main entrance of the house

The courtyard

It is a two-storied house, with a hipped roof sloping down into the central courtyard. This allows not only light to flow into the central core, but rain as well, and the water is collected and drained off through an outlet provided at the floor level.

Low wooden ceiling

Wooden windows

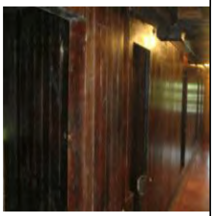
Large wooden windows punctuated and openings covered by a wooden plank for the shutter which doubles up as a seating when it is opened.

On reaching the first floor, the whole space expands into a large hall with a low wooden ceiling and has wood partitioned rooms in the corners .

Elegant interior of the house

The first floor of the house.

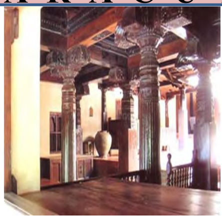
wooden column supports the wooden swing



wood partitioned rooms

H U N G A R A C U T T A   B A N S A A L E   M A N E

Main entrance of the house



Elegant interior of the house

Bansaale refers to a trading house and warehouse. The houses were built along the coastal towns / riversides to facilitate trade between production and consumption centres. Trade happened through river and sea.

The structure of the Hungaracutta Bansaale mane was planned in such a way as to facilitate and merge the dual purpose of its function as a workplace and residence very effectively. The front portion facing the harbour, logically became the business block while the trader's residence portion was located at the rear separated by a court left open to the sky.

The main roof slopes down covering a tapered wood pillared portico on either side of the main entrance.

As the *Bansaale mane* was located on the banks of the river facing the sea it was roofed with steep slopes and deep overhangs to ensure the drainage of the monsoon effectively so that the commodities stored remained dry.

Robust circular and square columns with heavy brackets carved with geometrical patterns span the whole interior of the business area providing the customer an impression of awe coupled with stability and prosperity, indicating the status of the trader in the local community

Intricately carved wooden column

Corporate office of the trader

VADERHOBLI HOUSE

Frontage of the house

The juglies; the upper one has robust square-shaped pillars with a bell-shaped capital and a bracket assembly that support a planked ceiling resting on thick beams and joists, the lower jugli has tapering octagonal columns.

The hall opens into a narrow balcony covering its entire length, with a square projection with ornate columns.

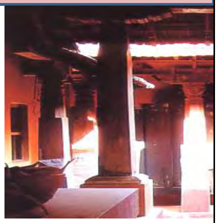
Rear side of the house

Balcony of the house

A lean-to-roof projecting from the wall -- the rafters being unusually deep and curved, rest on slender columns and covers the walkway running across its length.

BYNDOOR-NELYADI HOUSE

The house is a combination of the *hebbagila chavadi* and a series of functional areas positioned around a open-to-sky court. Huge ornamental doorway in the center of the wall cuts the inner and outer verandahs into two spaces.



Entrance door leading to the courtyard

Frontage of the house

The outer verandah serves as the social space, where visitors, traders who call on the landlord are met, and the family uses the inner space as a living area.

The usage of rosewood for the columns and much of its structural components coupled with intricate precise carvings made by traditional wood carvers or *gudigaras*, indicates the prosperity of the family.

Main entrance

YERUKONE HOUSE

Main entrance

The *hebbagila chavadi* serves as the meeting forum. The close relative would wait on the same verandah by his side. The trader, would sit at the same level but on the opposite verandah.

The public or an acquaintance would sit on the lower verandah and, the farm-tenant would stand just beneath the lower verandah. Each class of people had a designated place in the *chavadi*

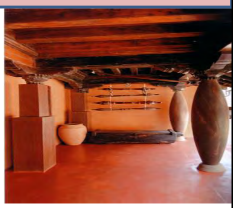
Doorway

View of the house

The front block is rectangular in plan, sitting on a high plinth with pillared two-tiered verandahs running along its length on both the faces of the house, separated by a wall.

HARKUR OLAGINA MANE

Hebbagila chavadi is a high verandah on two sides of both the exterior and interior, separated by a large wide door, which was kept open through the day. The verandah on both exterior and interior were lined with wooden pillars.



portion of the portico

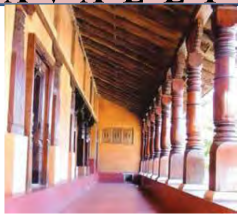
The unique feature is that the columns of the front verandah are modelled to resemble the mridangam, a percussion instrument associated with the folk art form of Yakshagana and Carnatic music

The columns in turn support a robust grid work of beams and joists planked to function as a ceiling. The central part of the verandah ascends to form a jugli, highlighted by two stout maddale pillars.

Frontage of Harkur Olaginamane with a chain of drum-shaped load-bearing wooden columns

HENGAVALLI KORRA HOUSE

Frontage of the house



Front verandah of the house

The house consists of an outer pillared verandah, attached to an 'L'-shaped *jugli* of the main house. This verandah with its stout wood-turned columns, placed successively along its length creates an impressive colonnade. A high ceiling panelled to the lean-to-roof resting on these columns adds volume and richness to this *jugli.*

High quality timber were used for the house construction. The Korra family used ample amount of timber to build this house few decades ago. The entire load of wooden logs was brought to the site for turning on wooden lathe to make circular columns to support the outer verandah of the house

The 'L' shaped jugli with square-shaped columns, accessed from this verandah, serves as the space for the family to have get-together. A small independent room at the end of the 'L' is used to store implements and tools associated with agricultural operations, the principal occupation of the house owners. A long ledge all along the southern wall serves as a seat or to lie down and has a storage facility at the base.

The whole spatial arrangement in the interior is compact and a low wooden ceiling further enhances the coziness of the space. A small wooden staircase leads to the first floor where rooms are created by partitioning of the whole floor

Upper jugli of the house

Wooden pillar

BHATKAL NAVAYATH MUSLIM HOUSE

The exterior of the Bhatkal Navayath Muslim House

Navayath pocket present a delightful spectacle of wood-rich houses each blending with the other in the most harmonious way. The ornate main door has couplets from the Holy Quran engraved on the lintel, placed centrally to the width of the house.

The front jugli of the house

Two cylindrical pillars with richly carved brackets define the entry into the fore-part, while two half-pillars rest touching the wall on both ends.

A well-made wooden ceiling rests on a beam running across the entire width of the house, taking support from these four pillars. The most unique element which has no precedence in any other vernacular architecture of Karnataka, are the seats positioned between the full and the half-pillar on both the sides.

A latticed

The seats finely shaped and successively placed vertical elements that hold a cornice handrail, which provides the user, an armrest.

Intricate carving

A small lean-to-roof with delicate rafters offers protection to the wooden seats and jugli in the verandah.

Ornamental window

Wood . . . A natural resource

QUALITIES OF WOOD

- Wood is a historic, classic and durable building material.
- Wood has good tactile warmth, aesthetics and longevity.
- Wood is one of the oldest materials that have been used in the construction and probably the most versatile.
- Wood is the only renewable source for building materials.

Wood . . . A renewable resource

Courtesy: APA_Green_Building_Brocure

- Wood is the only single major *renewable building material*, and it also requires less energy to manufacture than any other building material.
- It comes from forests that are continually being *replanted* as they are harvested. This practice ensures a plentiful *supply* of wood for construction and for innumerable of other uses.
- Young forests grow vigorously and store greater *quantities of carbon*. As trees mature, this rates lows down.
- Harvesting older trees helps keep the forests young while at the same time locking up carbon in our buildings. From this perspective, it is better to *harvest* a forest before it is over mature.

Wood . . . Green building material

- **Life Cycle Assessment (LCA)** shown that wood offers clear environmental advantages over other building materials.
- LCA has assessed the overall effects of building material on the environment which includes all activities from material extraction/harvesting through manufacturing, transportation, installation, use, maintenance, disposal and reuse.
- When considering environmental impact using Life Cycle Assessment, wood outperforms steel, concrete and glass *in the following ways:*

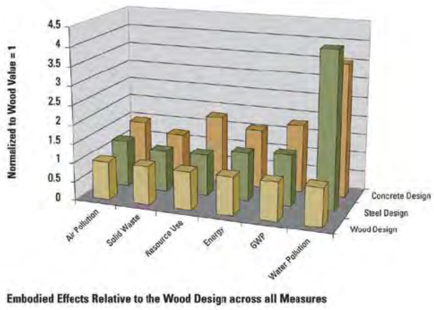
Embodied energy in production

Emission of greenhouse gases

Release of pollutants into the air

Generation of water pollutants

Production of solid wastes



Courtesy: Sustainable_Building_Series_01

Wood for sustainable development

What is sustainable development . . . ?

"Sustainable development is a development pattern which focuses on efficient resource use to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations to come".

Quote by Brundtland (1987).

Wood for sustainable development

- Wood ***restores*** the carbon dioxide and then purifies the air we breathe.
- Wood adds oxygen into the air but also absorbs the carbon dioxide ***greenhouse gas***.
- Man-made building materials simply add harmful pollutants to our environment in the process of manufacturing. while dynamic nature of a growing forest helps the ***environment***.
- Using wood for the construction will keeps this ***natural cycle*** unbroken.
- Maintains healthy forests, and thus promotes a better environment for earth's inhabitants.
- Sustainability is also about maximizing the resources that are ***locally available*** so as not to waste, damage or exhaust them.
- The longevity of buildings makes it even more important to use sustainable construction to maximise the ***efficiency*** of the building and the ***quality*** of life for future generations.

Advantages of wood over other building materials . . .

- Wood is energy efficient building material when compared to other building material.
- The manufacturing process for wood is more energy efficient than the manufacturing process of any other structural building material, and a building constructed with wood will be energy efficient as well.
- Wood balances out the temperature changes in different times of day keeping the interior temperature comfortable.
- Wood also possesses significant, positive environmental attributes.

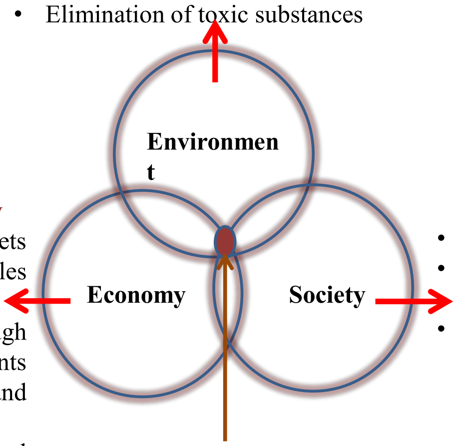
Courtesy: APA_Green_Building_Brocure

- Wood requires less energy in the manufacturing process than any other building materials like cement, glass and steel.
- The selection of environmentally responsible building material is an aspect of sustainable building.
- Wood is thermally efficient and easy to insulate.

Wood for sustainable development

Environmental Sustainability

- Reduced waste, effluent generation, emissions to environment
- Reduced impact on human health
- Use of renewable raw materials
- Elimination of toxic substances



Human Well Being

Economic Sustainability

- Creation of new markets and opportunities for sales growth
- Cost reduction through efficiency improvements and reduced energy and raw material inputs.
- Creation of additional added value

Social Sustainability

- Health and safety
- Impacts on the society and quality of life.
- Benefits the society

Sustainable construction

According to an OECD Project,

"Sustainable building" can be defined as those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting".

Vernacular Architecture as a Sustainable Built Form

- The vernacular houses were built relating to environmental context, using local available materials and utilising traditional technologies and have evolved over time to reflect the environment, cultural and historic context.
- It was influenced by a wide range of different aspects of human behaviour and environment, thus leading to different building forms for almost every different context.
- The houses have various devices that are built into their design
- The building forms were greatly influenced by the lifestyle of the occupants and the way they used their shelters.
- These houses are the witness of the skills in the workmanship and craftsmanship of ancestors. The buildings reflected the thoughtful process of the ancestors and the way of their life, culture and tradition.
- The vernacular architecture was built to meet specific needs of the people, accommodating their values, economies and ways of living of the culture by the people.

Mud and wood, the locally available materials were used for the construction extensively in the region. These materials were used for superstructure in the majority of the buildings. The walls were of mud mortar and were supported on granite foundation. The pitched roofs are of wooden rafter covered by mangalore tile.

The wooden columns and the beams acted as the structural members and the mud walls also took the load of the roof in some places and acted as barriers in some spaces of the house

Vernacular Houses

- Wood has been extensively used as a building material.
- The extensive use of wood, which is an easily workable material, has led to a profusion of detailing and ornamentation in the houses.
- The houses reflect high order of workmanship and craftsmanship prevalent in the region about centuries ago.
- The higher the status of the owner of the house the more elaborate are the carvings and decorative features.
- The massive, heavily carved wood work is supported by heavy wooden column which is beautifully carved shows the workmanship and craftsmanship of the ancestors

Detailing And Ornamentation In Wood

Doors and Windows

Doors and Windows

Ornamental Wooden Column

Ornamental Wooden Column

Ornamental Wooden Column

Ornamental Wooden Column and beams

Ornamental Wooden Column and beams

Intricately carved Wooden Column

Portico of house

Courtyard in the house

Wooden ceiling

Interiors of the house

Conclusion . . .

- The regional architecture has an incredible potential for influencing the current architectural trends in that region.
- The vernacular architecture is not only to study about the past history, culture and traditions, but also should contribute to the present and future needs of the built form.
- We should understand, appreciate, preserve, conserve the cultural heritage of the region and also enhance the environmental quality of the vernacular architecture which has been handed over to us for generations from our ancestors.
- The design principles and approaches of the vernacular houses should be implemented for the building we design and build.

Conclusion . . .

- Vernacular house have low impact on the environment over the contemporary buildings.
- There is a need to grow more forests, from this there is enough production and supply of wood and wood products for the construction industry.
- We need to ensure that the treasure we have i.e., the forests will be there for our future generations and helps the natural cycle to be intact also.
- The vernacular houses of the region will serve as an inspiration for the future posterity and contribute to sustainable development and present new opportunities for development of the wood.

References . . .

Ajai Chandran, C, K, and Krishne Gowda, 2010, Social Perspective of Heritage Dwellings: A case study of the 'Hirebettu House', Institute of Town Planners, Indian Journal 7 – 4, page number 37 – 44.

Anantha Krishna, K, S, Deshmukh, R, P, and Rewatkar, K, P, 1993, Passive Cooling measures in Vernacular Houses of South Kanara, Proceedings on Energy Efficient Buildings and Building Materials, Cell for Renewable Energy Dissemination activities, Karnataka State Council for Science and Technology, Indian Institute of Science, Bangalore.

Ashwani Kumar and Navneet Munoth, 2011, Vernacular Architecture: A prerequisite for sustainable development, Architecture – Time Space and people, Volume 11, Issue 7.
Barbara Horwitz-Bennett and Sullivan, C, C, 2008, Using wood for sustainable design, Building Design + Construction.

Brundtland, 1987, Report of the World Commission on Environment and Development – our common future, Oxford University Press, Oxford.

Ilay Cooper and Barry Dawson, 1998, Traditional Buildings of India, Thames and Hudson Ltd, London.

Saga of the Poor Man's Timber

Neelam Manjunath[6]

Abstract

Once upon a time, millions of years ago, in prehistoric times, man discovered a giant grass in the wild forests- bamboo! It became the Kalpavriksha for him. He built his house with it, protected it with Bamboo forts, used it as firewood, made weapons, cloths, musical instruments etc and after death was carried and buried with it. He developed a Bamboo Civilization with indigenous technologies for various uses, like transportation, handmade paper, water distribution pipes, medicines, housing, etc.

Fast forward to 18th century, the British Empire has colonized half of the world, the Industrial Revolution is unfolding and modernization is accelerating. Machines are being used more and more, for every task. Wood processing became easier and replaced Bamboo in many applications. Steel and cement was discovered. Man started using factory produced materials. Bamboo usage declines, with only the poor using it because they could not afford the new processed materials. As a result this Kalpavriksha came to be labeled as the poor man's timber.

Now in the 21st century, the world is gripped by fear of Human civilization being wiped out due to environmental degradation and global warming. Conferences, seminars, workshops and rallies across the world are talking about the ill effects of industrialization and urging the world to 'return to nature'. And in this call for return, the so called poor man's timber is now being hailed as the wonder material by the Global community, especially for the building construction sector - the largest polluter in any country. A bamboo renaissance is taking place!

The technology of construction with Bamboo is the greatest contribution that the South and the Eastern world can give to Sustainable Development.

I will be presenting three of our projects which underline the return of this wonder material as the most modern and fashionable material today, namely; Bamboo Symphony, Bangalore; House of Five Elements, Bangalore; and the Police Bhevan, Bangalore.

Keywords: Bamboo, Sustainability, Material and Technology'

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A BAMBOO RENAISSANCE IS TAKING PLACE!

The world is turning towards regional technologies and two definite categories of development are emerging - one based on the principle of recycling and the other on the use of natural materials capable of being used without requiring industrial processing. Mud and bamboo figure prominently in this second category of development.

Bamboo is a premiere building material in the new architectural movement with sustainability and an integrative approach as its two important criteria. This is high science and simple technology. Bamboo plays a key role in the lives of 1/5 of the world's population even today. However, in many places expensive wood, steel, concrete, glass etc have replaced bamboo.

Figure 1: Bamboo Tree **Figure 2: Bamboo house in Ancient times**

3. 
4. 
5. 
6. 

Figure 3: Poor people's bamboo house
Figure 4: Bamboo bridge
Figure 5: Bamboo fishing platform
Figure 6: Prehistoric Tools

Figure 7: Various uses of bamboo in historic times

Figure 8: Bamboo in paper making

Figure 9: Bamboo water-pipe in Hongkong before 1983

Figure 10: Bamboo Innovations in building construction technology

I will be presenting three of our projects which underline the return of this wonder material as the most modern and fashionable material today. These are: Bamboo Symphony, Bangalore; House of Five Elements, Bangalore; and the Police Bhevan, Bangalore.

All these three buildings represent are our effort to reverse this trend and replace steel, concrete etc with bamboo.

1. House Of Five Elements, Bangalore:

This house is a residence with a built up area of 10,000 sqft. The building has been used for various experiments with natural building materials, low energy materials and construction technologies etc. The entire construction was done by unskilled workers, with labor training provided during construction. In this building Bamboo has been used in combination with other building materials like mud, stone etc and the new age material- waste. All the load testing of the bamboo roof and other design tests were done by us on site before the final execution. Excavated soil from site has been used for production of stabilized mud blocks for the house. Stones from the excavation have been used extensively for landscaping.

The main usage of Bamboo in the house is in the following components:

1.1 Bamboo ply for all the doors and 1” bamboo round poles for ventilators;

1.2 Bamboocrete walls in the entire first floor and partition wall in the house A prototype of Bamboocrete wall from prefabricated panels was made before using it in the First floor;

1.3 Bamboo mat corrugated sheet roofing with gypsum board false ceiling;

1.4 A double curve shell roof on bamboo structure. The bamboo roof is a 3500 sq ft double curve concrete shell roof with a span of 8.5m-10m and length of over 45m, covers the core area of the house from east to west, with verandahs on both sides and a courtyard in between. It has been designed as a lightweight roof (2” RCC slab) with minimal reinforcement supported on two curved triangular bamboo beams simply supported on bamboo columns of varying heights following the curve of the roof. A grid matrix of 1” bamboo splits at 6” centre to centre hold the screed concrete in place. It is based on the principle that “a material can bear more loads when it is curved”. A tarpaulin which is painted on one side is placed before concrete above the split bamboo mat, which acts as a water proof member in place of plastic. Thorough documentation of project workshops, tests, training programmers has been done for dissemination of information to propagate the Low energy or Zero energy concept of Sustainable Communities. The cost of construction of the house is extremely low because of the use of local materials and construction technologies; effective usage of 100% construction waste, efficient infrastructure design etc. The project has already been presented in many National and International Forums.

Figure 11: Glimpse of House of Five Elements

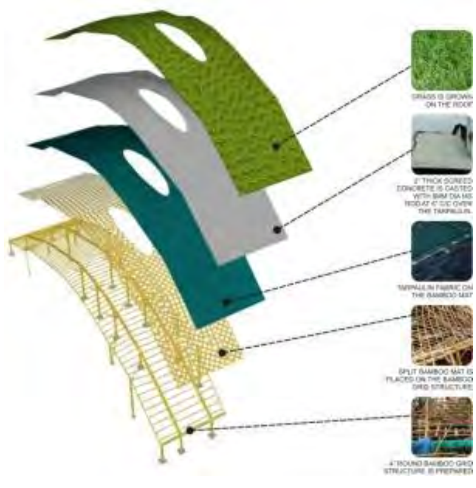


Figure 12: Roof layers

Figure 13: Double-curve roof profile

Figure 14: Roof Details

Figure 15: Bamboo Crete wall

This house is an example of bamboo being used with other building materials to produce an extremely aesthetical Architecture.

2. Bamboo Symphony, Bangalore:

This is an office building of 1500 sq ft area, designed as an open plan office with spaces divided by level difference rather than physical walls. The most interesting part of the building is its structure based on the traditional fisherman's platform- a true synergetic structure!

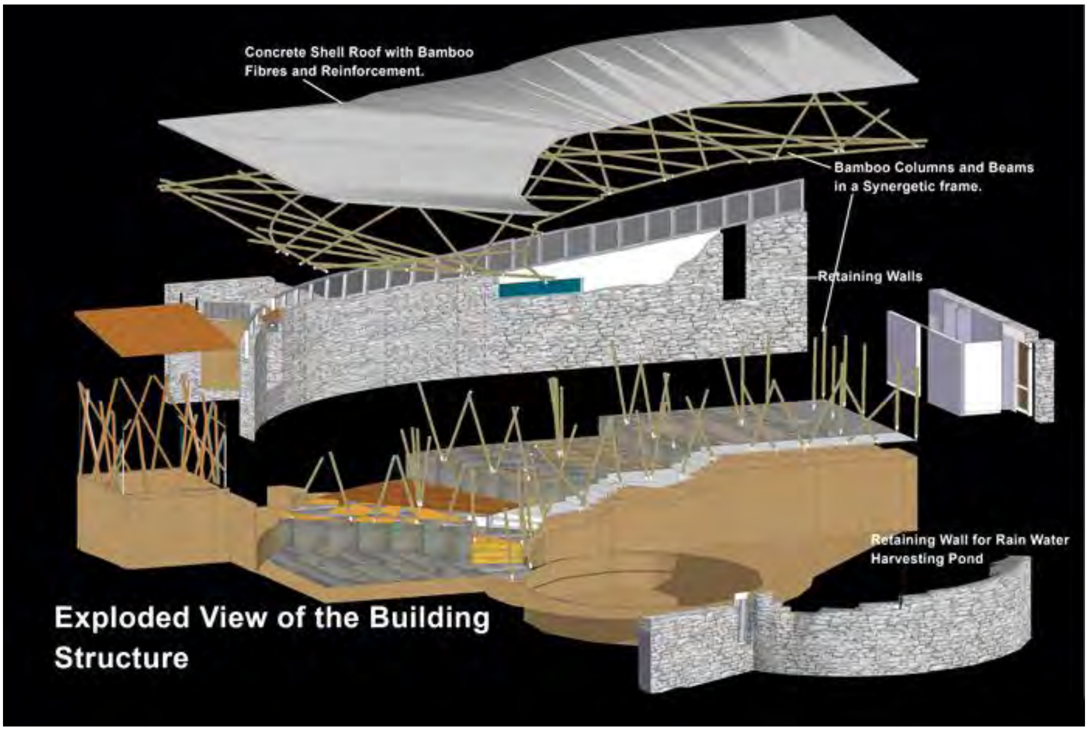


Figure no 16: Evolution of Bamboo Roof in 'Bamboo Symphony'

This building is designed as a closed loop for the building materials, processes and technologies. The structure of the building is its most unique feature. It is based on the model of synergetic and tensigrity structures. It has been designed as a hybrid of the two systems and was physically tested before concreting the roof. These types of structures are being made across the world with modern materials with high energy balance. Bamboo is the only Natural building material with lowest energy balance that can be used for these structures.

The materials of construction details: bamboo-crete walling system with precast wall panels, usage of stabilized mud blocks from the site, green shell roof over lattice grid made of bamboo culms and supported on bamboo columns & amp, beams, bamboo reinforced concrete with bamboo fibers for reducing the weight of the concrete, bamboo flooring, bamboo column and beams. The columns in Bamboo Symphony, although they look haphazardly placed, have a definite position, size and inclinations, i.e., they are structurally relevant, just like the highly evolved technological logic we find in nature. The roof was allowed to define its own shape as per the flow of forces, naturally, like a fabric assuming its shape. These structures are highly efficient with minimal energy use and amp.

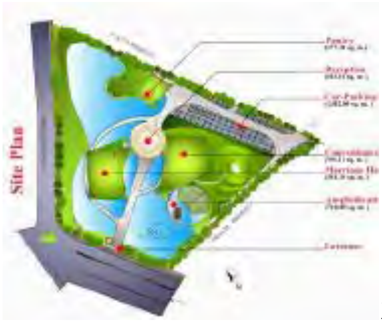
17.  18.  19. 

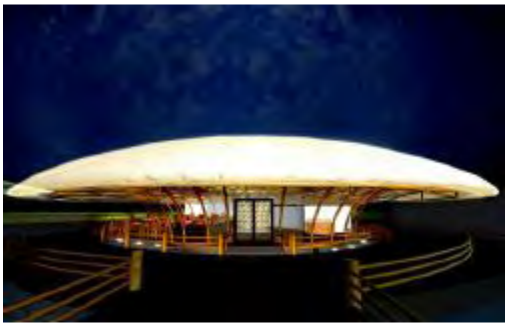
20.  21. 

Figure 17: 'Bamboo Symphony' at dusk
Figure 18: Japanese guard
Figure 19: south side view at west-side of 'Bamboo symphony'
Figure 20: Architect's cabin
Figure 21: Reception

3. Police Bhevan, Bangalore:

This project was a competition project by Karnataka State Reserve Police Dept, Bangalore to create a landmark building for their Golden Jubilee celebrations. Total built-up is about 3855.67 Sq.ft. In this project bamboo is used extensively for various elements of the building. All the roofs except for the reception are double curve shells of ferro-crete or bamboo-crete roofs BIPV (Building Integrated Photo-Voltaic cells) for bringing in natural light to the interiors. Other than the roof we have used it for all the structural elements and bamboo railing, furniture's etc. as well.

22. 

23. 

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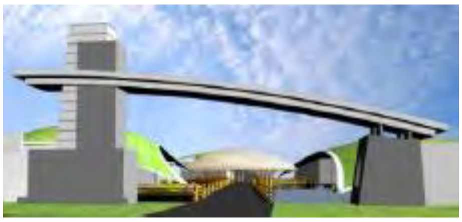
26. 

Figure 22: Site plan
Figure 23: Reception
Figure 24: Amphitheater view
Figure 25: Development of roof structure in bamboo
Figure 26: Entrance

The project site is a filled up lakebed. We have designed the whole project as a cluster of Islands connected by bamboo bridges with modernistic buildings made with bamboo shell roofs of about 2500 sft, bamboo dome----sft etc. In the process we proposed the rejuvenation of the lake with wetland development for water filtration. However, we were runner-up in the competition- hence it has not been constructed.

4. EPILOGUE

All of these projects are examples of the improvised traditional building, where local traditional building elements, styles and technologies have been used to revive them and add context to the architecture of the buildings themselves. The projects have been developed as attractive, self sufficient buildings respecting nature in order to meet the environmental standards and run on low energy- Zero Energy buildings. These projects have been aimed at defining a new architectural style and language, and a new definition of the profession of Architecture in terms of Responsible Creativity and Creative Responsibility. Bamboo has brought together the so-called third world countries as equal partners in a fruitful exchange of ideas with architects of the industrialized countries. Only north-south and east-west complementarily can develop a fair and global practice of sustainable development and an appropriate and reasonable redefinition of our future. The technology of construction with bamboo is the greatest contribution that the South and the Eastern world can give to Sustainable Development.

5. REFERENCES

Marcelo villages, 2003, New Bamboo Architecture and Design 171

Simon Velez and bamboo architecture, 2000, Grow Your Own House, P141 – 167.

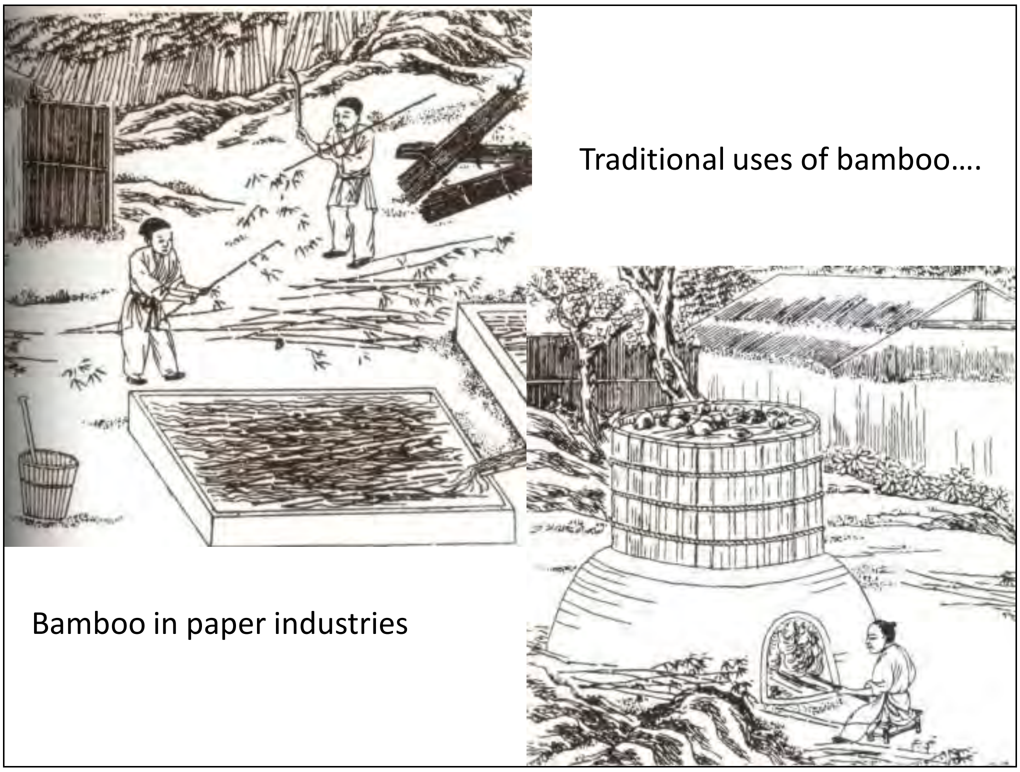
Hidalgo-Lpoez O, 2003, Bamboo the Gift of the Gods, 223

SAGA OF THE POOR MAN'S TIMBER…..

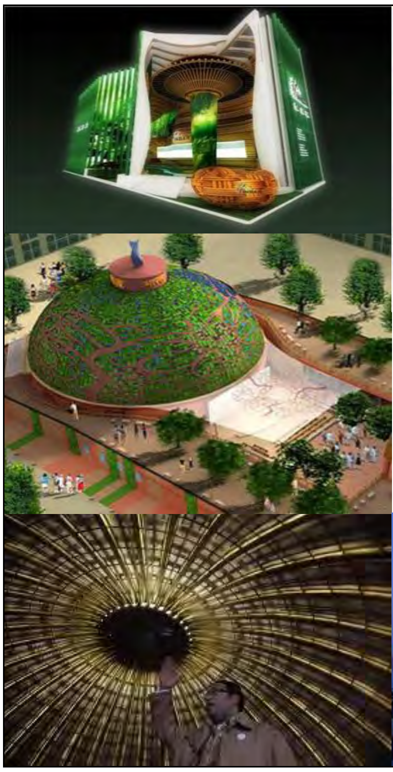
CGBMT ,BANGALORE ,INDIA

KALPAVRIKSHA

Once upon a time, millions of years ago, in prehistoric times, man discovered a giant grass in the wild forests---- BAMBOO! It became the KALPAVRIKSHA for him. He built his house with it , protected it with Bamboo forts, used it as firewood, made weapons, cloths, musical instruments etc and after death was carried and buried with it. He developed Bamboo Civilization with indigenous technologies for various uses, like transportation, handmade paper, water distribution pipes, medicines, housing etc.


Traditional uses of bamboo….
Bamboo in paper industries

Use bamboo in houses….



A BAMBOO RENAISANCE IS TAKING PLACE…!

Further forward to 21^{st} century. The world is gripped by the fear of Human civilization being wiped out because of Environmental degradation and Global warming. Conferences, seminars, workshops, rallies across the world are talking about the ill effects of Industrialization and urging the world to '**Return back to Nature'.** And in this call for return, the so called

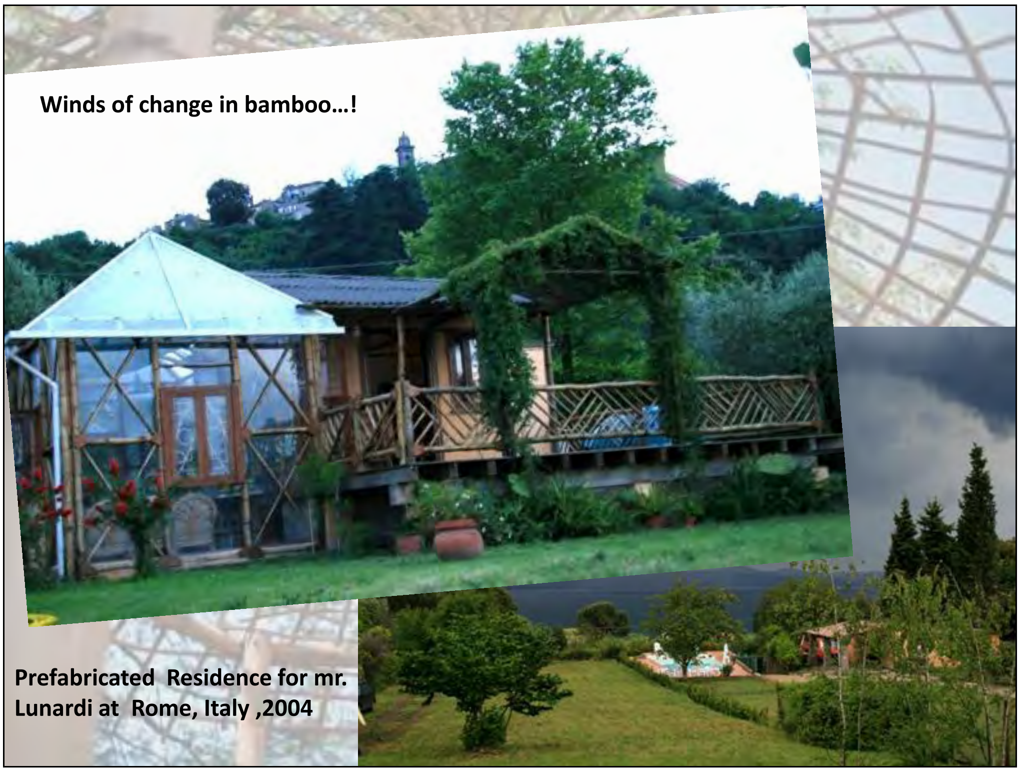
Winds of change in bamboo…!

Pantry and VIP toilet block
Raj Bhavan , Bangalore , India , 1999

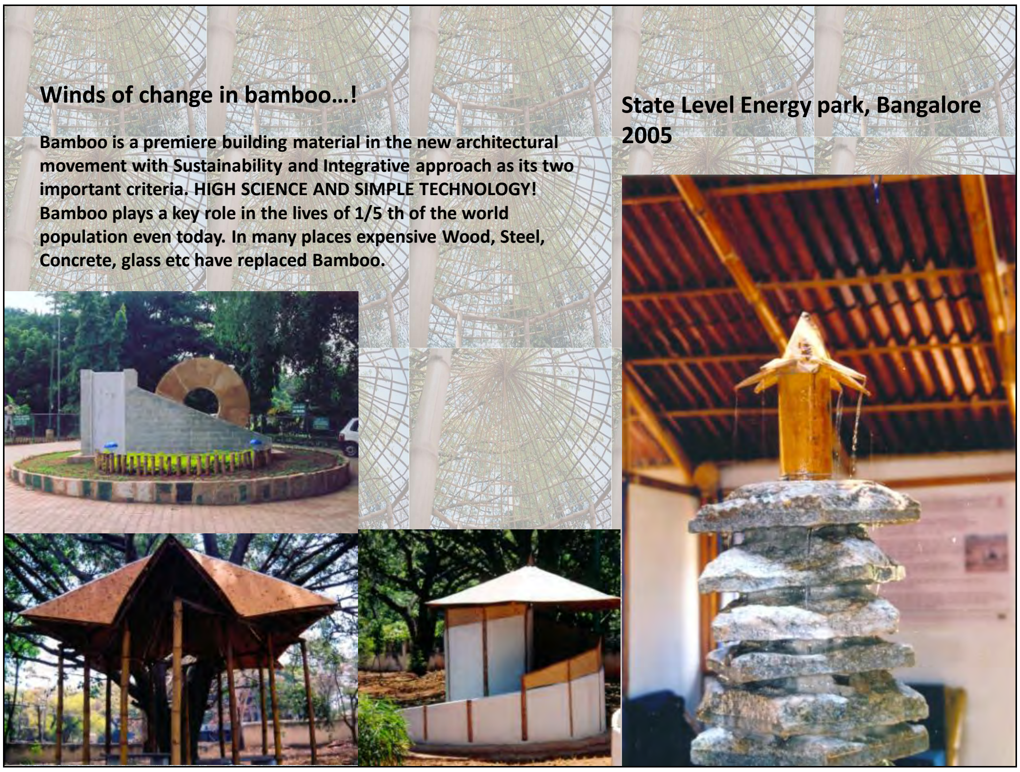
Winds of change in bamboo…!

IPIRTI, Bangalore,2003

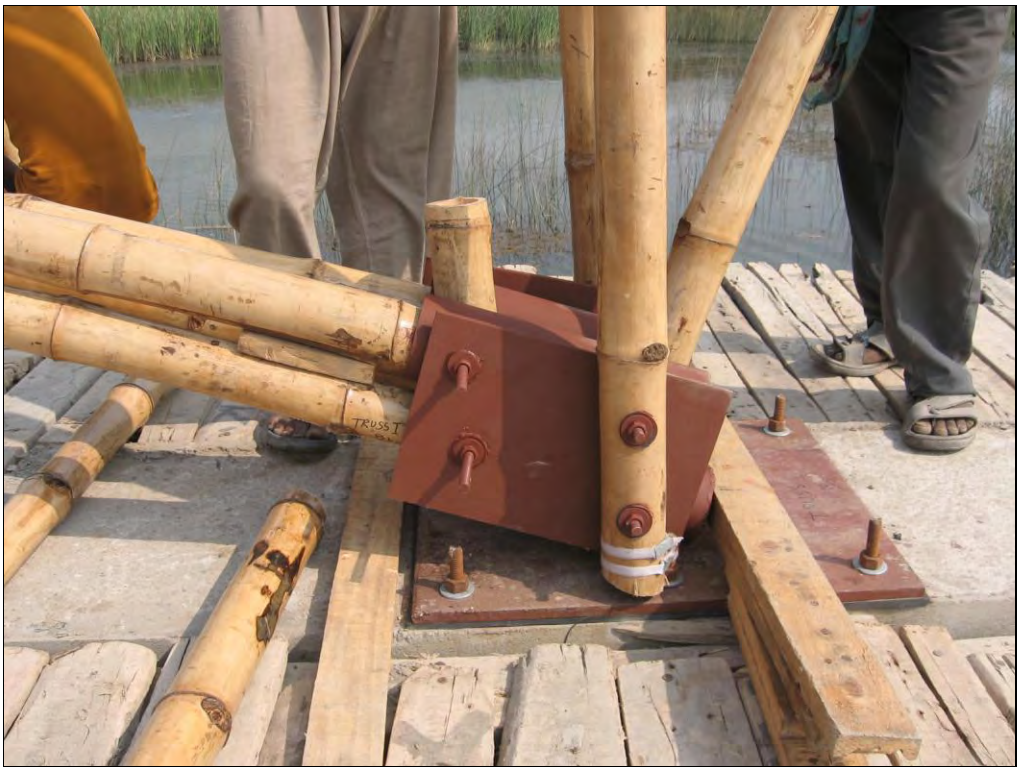
POOR MAN'S TIMBER IS BEING HAILED AS THE WONDER MATERIAL BY THE GLOBAL COMMUNITY, ESPECIALLY FOR THE BUILDING CONSTRUCTION SECTOR - THE LARGEST POLLUTER IN ANY COUNTRY. World is turning towards regional technologies and two definite categories of Development are emerging - one based on the principle of recycling and the other on the use of natural materials capable of being used without requiring industrial processing. Mud and BAMBOO figure prominently in this second category of Development.


Winds of change in bamboo…!
Prefabricated Residence for mr. Lunardi at Rome, Italy ,2004


Winds of change in bamboo…!
Views of Lunardi,s house in Rome, Italy


Winds of change in bamboo…!
Bamboo is a premiere building material in the new architectural movement with Sustainability and Integrative approach as its two important criteria. HIGH SCIENCE AND SIMPLE TECHNOLOGY! Bamboo plays a key role in the lives of 1/5 th of the world population even today. In many places expensive Wood, Steel, Concrete, glass etc have replaced Bamboo.
State Level Energy park, Bangalore 2005


Winds of change in bamboo…!
YAMUNA BIO-DIVERSITY PARK,2005




04/07/2007

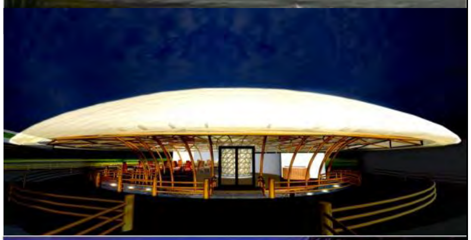

Winds of change in bamboo…!
Cafeteria at Ranal Engineering, Bangalore, India,2005


Winds of change in bamboo…!
Cafeteria at Ranal Engineering, Bangalore, India,2005

We will be presenting three of our projects which underline the RETURN OF THIS WONDER MATERIAL as the most modern and fashionable material today namely …..

HOUSE OF FIVE ELEMENTS, Bangalore

POLICE BHAVAN, Bangalore.



BAMBOO SYMPHONY, Bangalore

HOUSE OF FIVE ELEMENTS, Bangalore 2008-2010

This house is a Residence with a built up area of 10,000 sqft. The house has been used for various experiments with natural building materials, low energy materials and Construction technologies etc. The entire construction was done by unskilled workers, with labor trainings given during construction. In this building Bamboo has been used in combination with other building materials like Mud, Stone etc and the new age material WASTE. All the load testing of bamboo roof and other design tests were done by us on site before the final execution. Excavated soil from site has been used for production of Stabilized Mud Blocks for the house. Stones from the excavation have been used extensively for landscaping.

HOUSE OF FIVE ELEMENTS, Bangalore

The main usage of Bamboo in the house is in the following components:

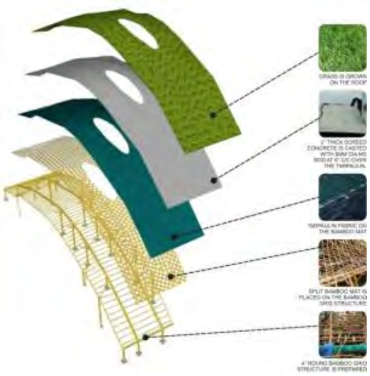
1.1 Bamboo Crete walls in the entire first floor and partition wall in the house A prototype of Bamboo Crete wall from prefabricated panels was made before using it in the First floor.

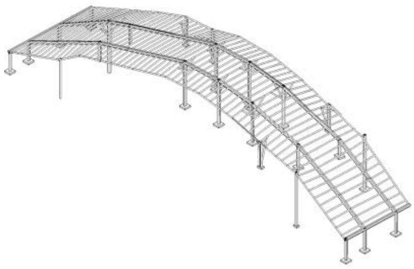
1.2 Bamboo ply for all the doors and 1”Bamboo round poles for ventilators.

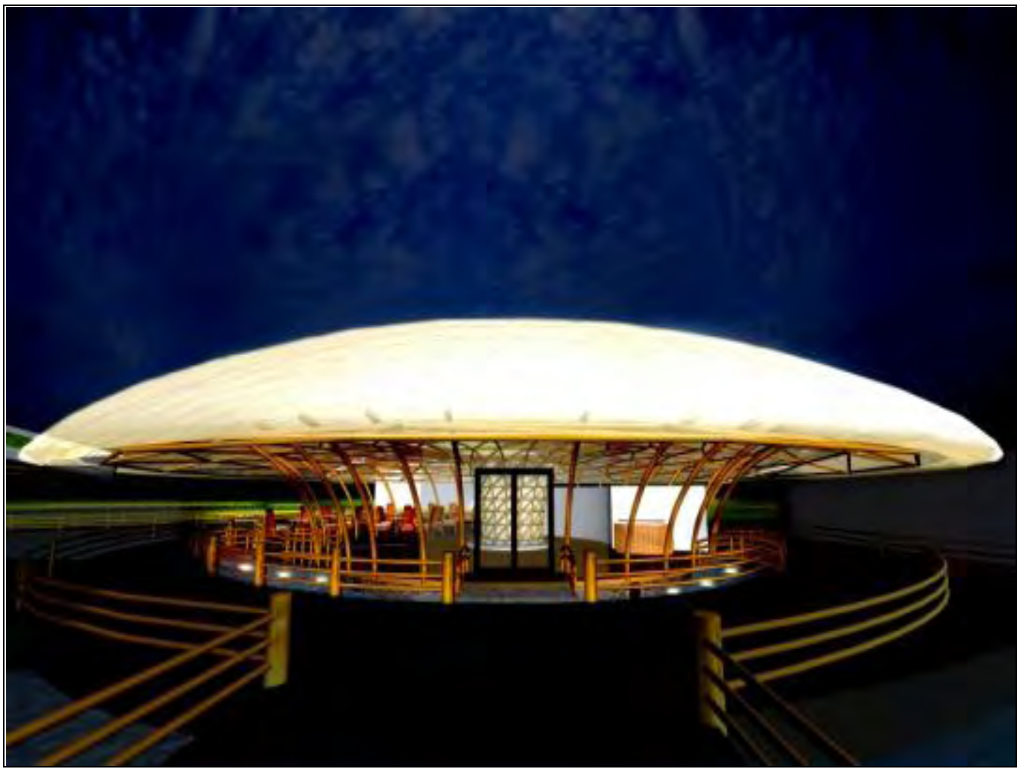
1.3 Bamboo mat corrugated sheet roofing with Gypsum board false ceiling.

HOUSE OF FIVE ELEMENTS, Bangalore

A double curve shell roof on Bamboo Structure - The Bamboo Roof is a 3500 sq ft double curve concrete shell roof with a span of 8.5m-10m and length of over 45m, covers the core area of the house from east to west, with verandahs on both sides and a courtyard in between. It has been designed as a lightweight roof (2” RCC slab) with minimal reinforcement supported on two curved triangular Bamboo beams simply supported on bamboo columns of varying heights following the curve of the roof. A grid matrix of 1” bamboo splits at 6” centre to centre hold the screed concrete in place. It is based on the principle that “a material can bear more loads when it is curved”. Tarpaulin which is painted on one side is placed before concrete above the split bamboo mat, which acts as water proof member instead of plastic. Thorough documentation of project workshops, tests, training programmers has been done for dissemination of information to propagate the Low energy or Zero energy concept of Sustainable Communities. Cost of construction of the house is extremely low because of the use of local materials and construction technologies; effective usage of 100% construction waste, efficient infrastructure design etc. The project has already been presented in many National and International Forums.



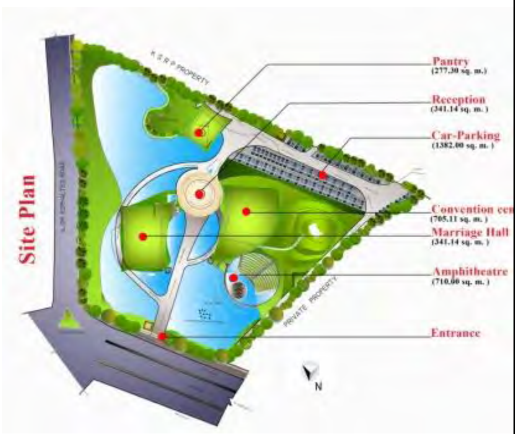


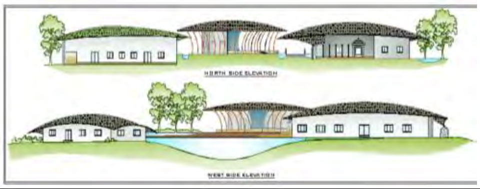


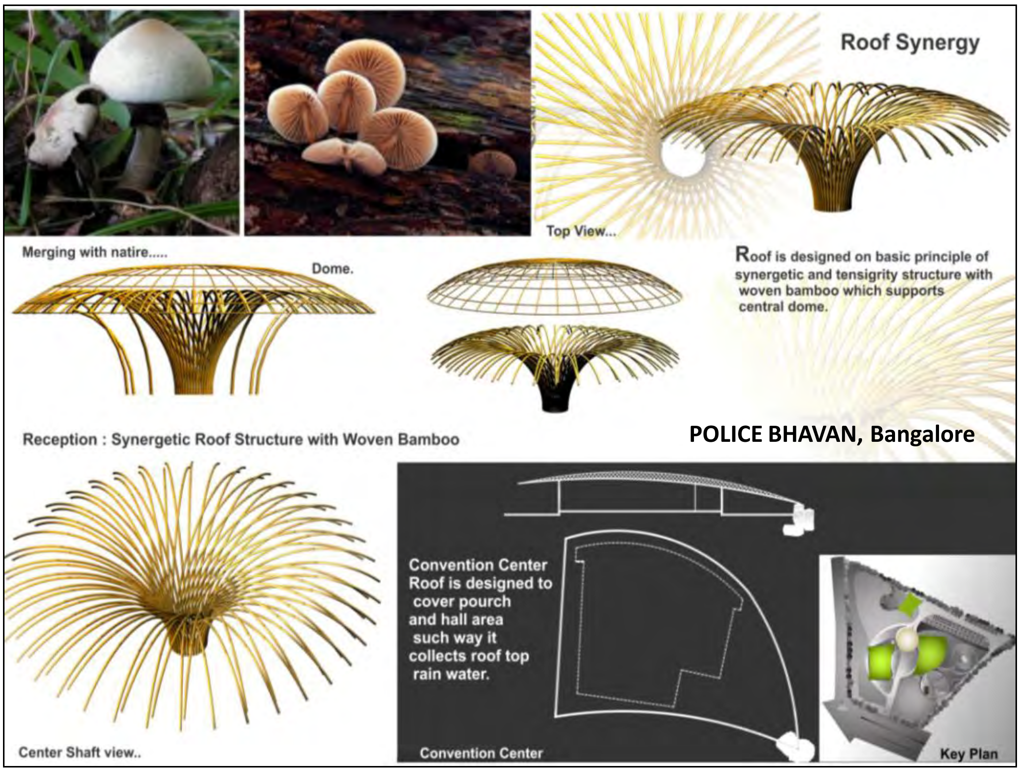
POLICE BHAVAN, Bangalore, 2010

This project was a competition project by Karnataka State Reserve Police Dept, Bangalore to create a landmark building for their Golden Jubilee celebrations. Total built-up is about 3855.67 sqft.

In this project bamboo is used extensively for various elements of building. All the **Roofs except the reception to be double curve shell Ferro Crete or bamboo Crete roofs BIPV (Building integrated Photo voltaic cells) for bringing in natural light to the interiors. Other than the Roof we have used it for all the structural elements and bamboo railing, furniture's etc. as well.**



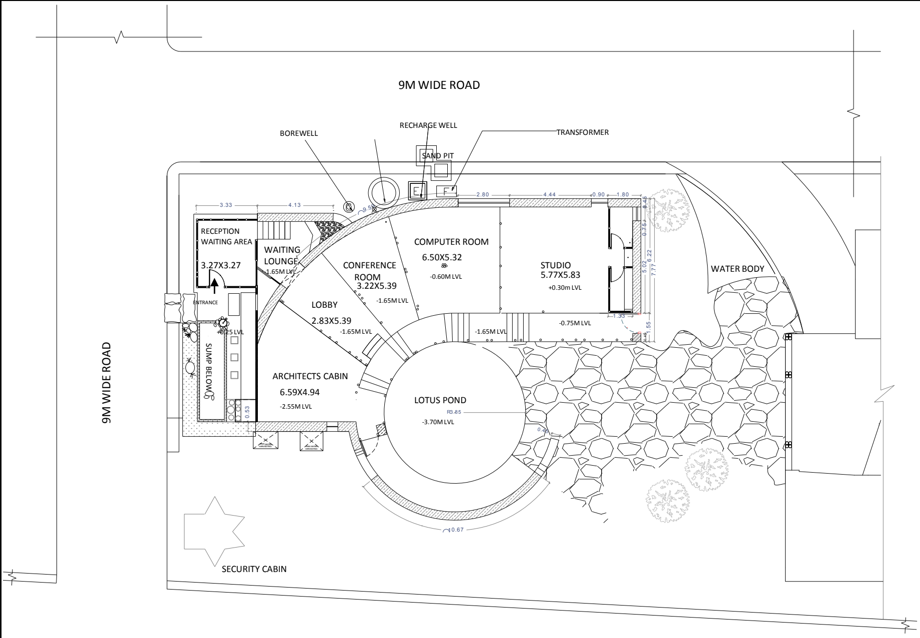



Roof Synergy
Top View...
Merging with natire.....
Dome.
Roof is designed on basic principle of synergetic and tensigrity structure with woven bamboo which supports central dome.
Reception : Synergetic Roof Structure with Woven Bamboo
POLICE BHAVAN, Bangalore
Convention Center Roof is designed to cover pourch and hall area such way it collects roof top rain water.
Center Shaft view..
Convention Center
Key Plan

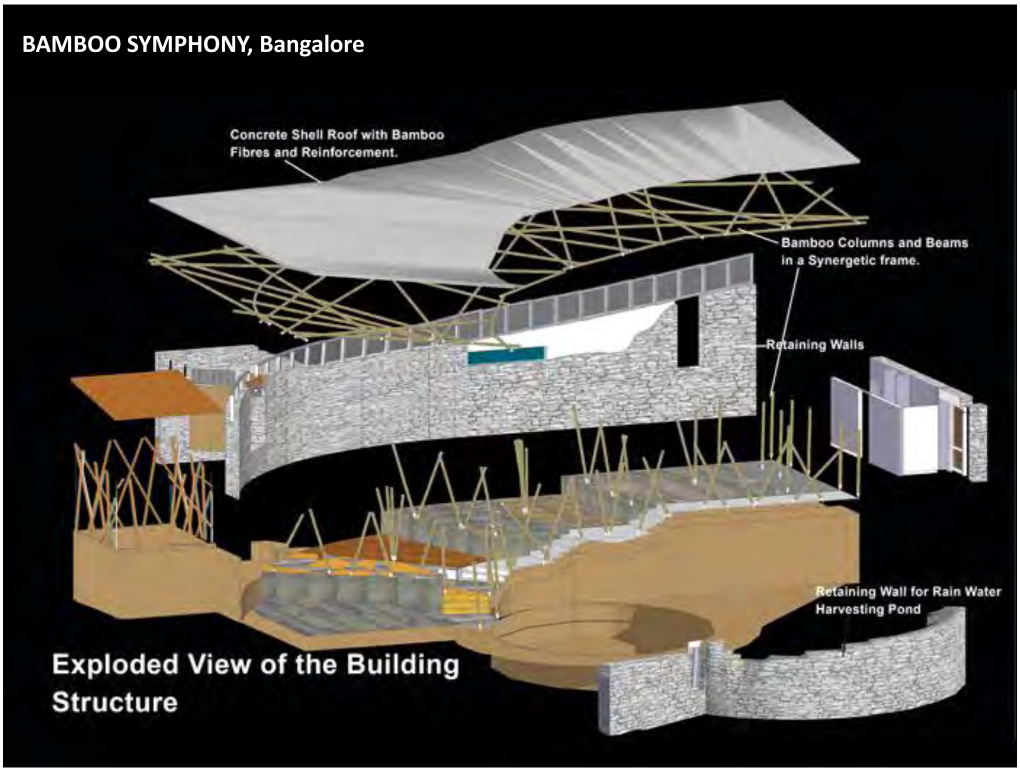
BAMBOO SYMPHONY, Bangalore

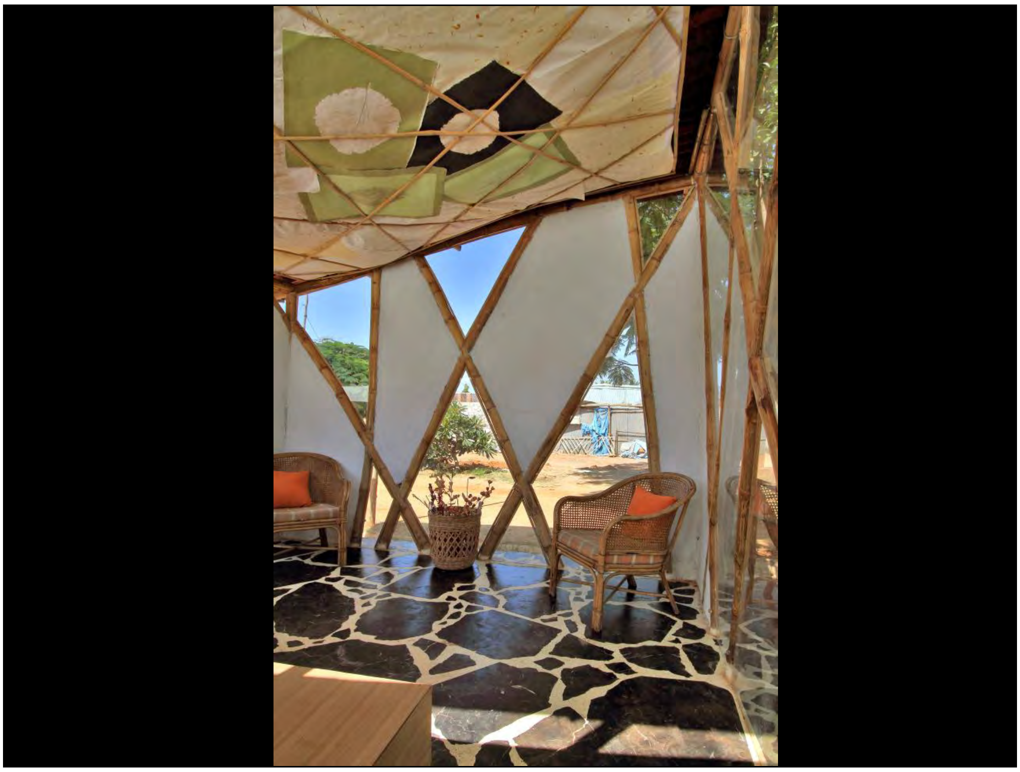
This is an office building of 1500 sq ft area, designed as an open plan office with spaces divided by level difference rather than physical walls. The most interesting part of the building is its structure based on the traditional Fisherman's platform- a true synergetic structure!

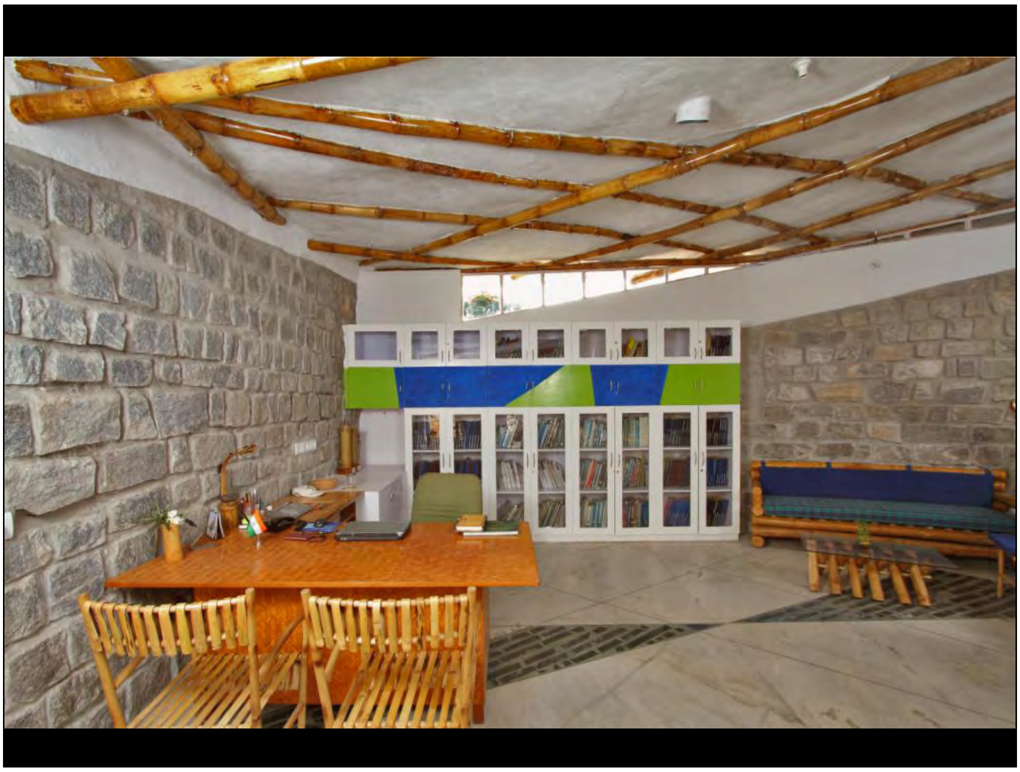
This building is designed as a closed loop for the Building Materials, Processes and Technologies. The STRUCTURE of the building is its most unique feature. It is based on the model of SYNERGETIC AND TENSIGRITY structures. It has been designed as a hybrid of the two systems and was physically tested before concreting the roof. These types of structures are being made across the world with modern materials with high energy balance. Bamboo is the only Natural building material with lowest energy balance that can be used for these structures.

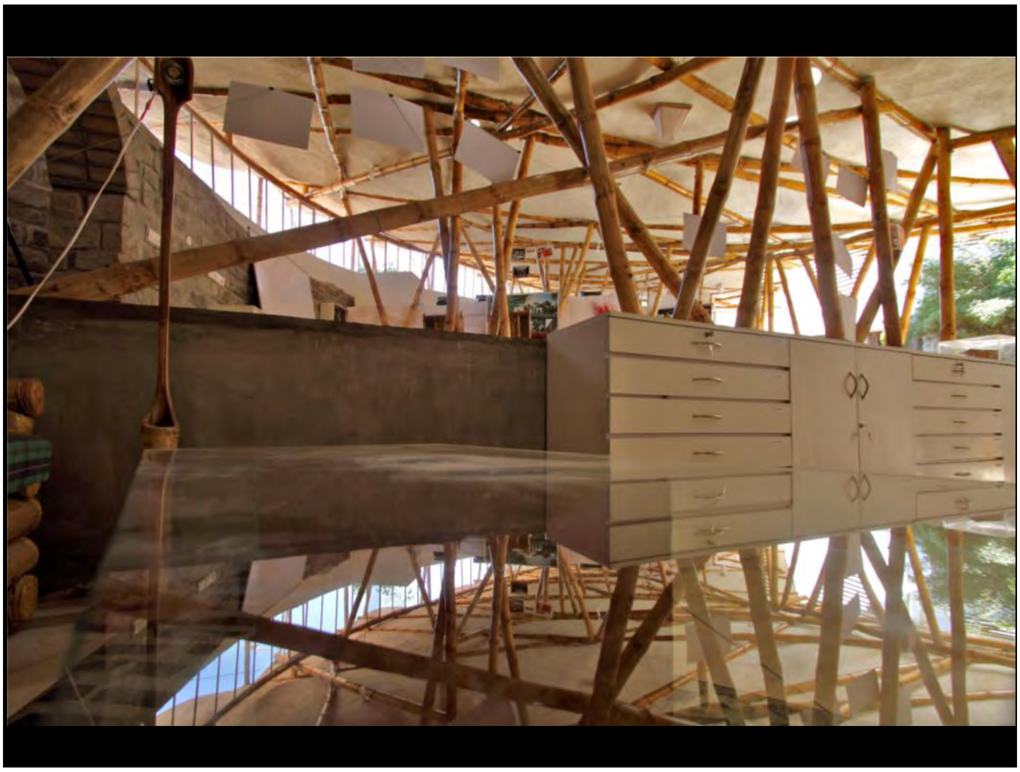


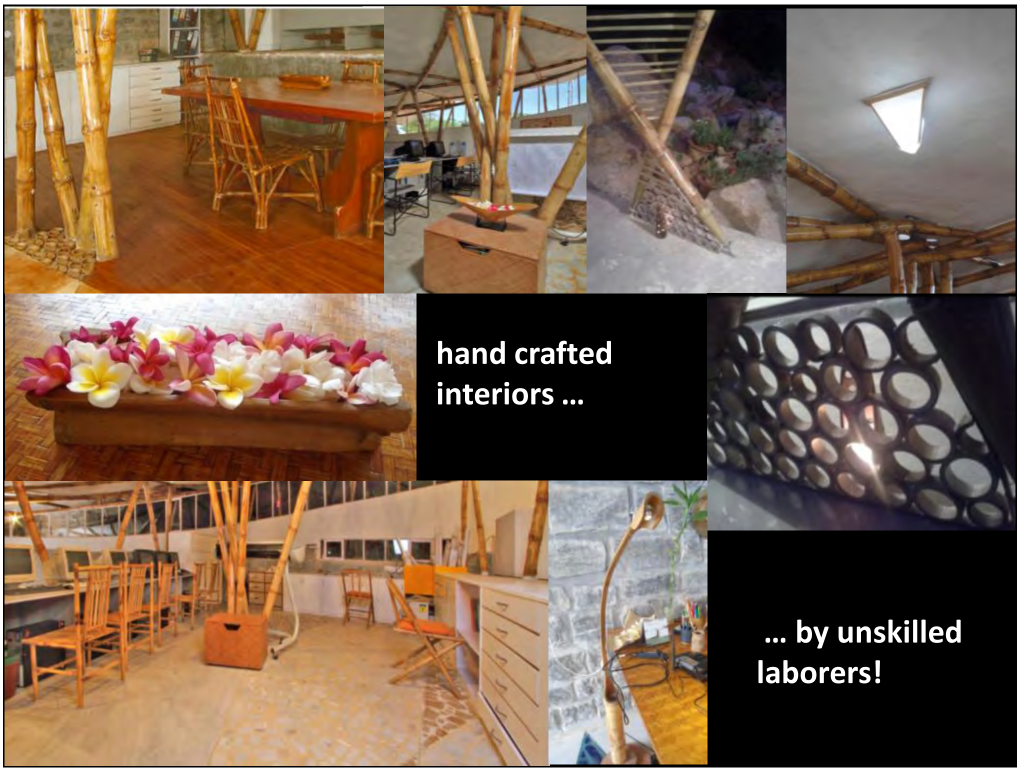
FLOOR LAYOUT PLAN


BAMBOO SYMPHONY, Bangalore
Concrete Shell Roof with Bamboo Fibres and Reinforcement.
Bamboo Columns and Beams in a Synergetic frame.
Retaining Walls
Retaining Wall for Rain Water Harvesting Pond
Exploded View of the Building Structure








hand crafted
interiors …
… by unskilled
laborers!