Bamboo Construction : Learning Through Experience

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Exploring Bamboo as a building material in making the vernaculars of architecture in India.

A workshop was arranged for the First and Second year B. Arch students of Dr. Bhanuben Nanavati College of Architecture, Pune for study of Bamboo as a building material and study of temporary structures construction. A team of 56 students visited Bhargav Fibers Shedhani, Taluka - Mulshi, District- Pune to study Bamboo and thatch as roofing materials for load bearing structures. Lead by Prof. Vaishali Anagal and Prof. Suresh Athavale the workshop was organized for students of architecture to acquire basic knowledge about bamboo in addition to get a hand on experience as far as use of this material in the construction of temporary structures is concerned.

As a part of this workshop, a cow shed was designed with bamboo wall panels and bamboo trusses with thatch roofing. Wall Panels were designed in such a way that students would be able to understand and execute a variety of

Cutting Bamboo

Bamboo Plantation

Drilling into Bamboo

Bamboo structure

Bamboo Workshop

Faces full of joy after successful attempt

joinery that is possible in bamboo. For that each wall had different configuration and a typical truss was configured. Students had hands on experience of cutting, drilling, bolting of bamboo and various types of joinery in bamboo. Students also studied existing structures that were constructed in bamboo i.e. a geodesic dome with thatch roofing.

The workshop was starded with an introductory lecture by Mr. Shrinivas Khare, properiter of "Bhargav Fibers' who is an eminent researcher in Bamboo construction. He discussed the uses of this magic material bamboo, its structure, growth, characteristics and advantages of bamboo as a construction material. Students visited Dev-raee (Protected Forest) and Bamboo plantation for study of various species of bamboo and their respective use in construction.

TETE- A -TETE ON BAMBOO

Tete- a -Tete session was organized with experts in the field of Bamboo at Dr. Bhanunen Nanavati College of Architecture Pune on 4th march 2009. The discussion provided students a platform to ask their queries and methods of using Bamboo for not just traditional and vernacular structures but also in our cities today. Many interesting perceptions and myths were talked about and cleared by the speakers. They stressed bamboo is a very low cost material and is used only for affordable construction, Bamboo can be used only for aesthetic purpose like landscape etc, only G+1 construction is possible in bamboo. The overall interaction was a very significant step ahead in the development of our

The discussion was aimed at exploring bamboo and its uses in an urban context.

Hands –on experience: Students of M.Arch Environmental Science working with bamboo for constructing a geodesic dome.

students and their approach towards bamboo along with our deeper interest being generated at forming a group of bamboo researchers and lovers at our college and work towards spreading the awareness about this wonder grass and its uses.

SIGNIFICANCE OF BAMBOO AS A RESOURCE

- 1250 known species of Bamboo, with 1500 possible uses.
- 2.5 billion people worldwide use bamboo, of which 1 billion people use it for housing
- Trade in Bamboo generates US $ 4.5 billion.
- Provides Livelihood, Ecological and Food Security.
- Eco-friendly Products

LIFE CYCLE ANALYSIS:

Manufacture/Usage/Implementation

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Extraction/Production

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Maintenance/Operational Life

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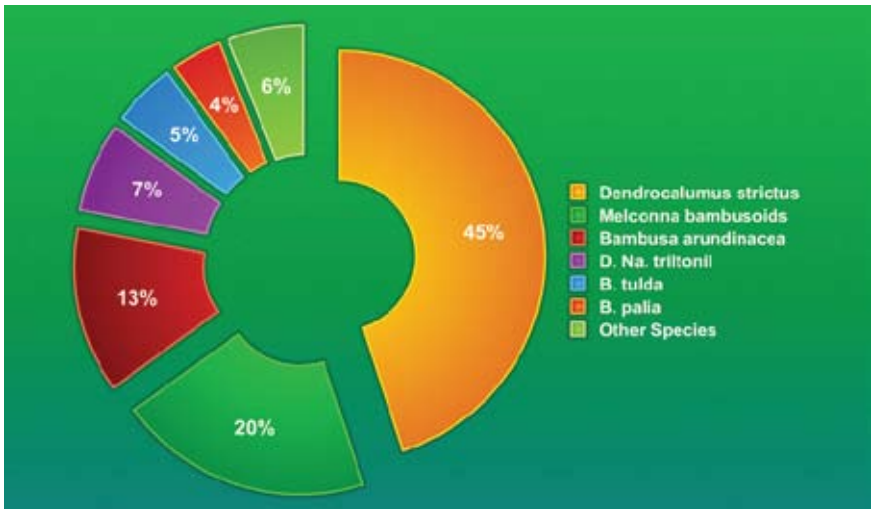
Disposal

SPECIES OF BAMBOO



Bamboos usually have a life-cycle of around 40 to 80 years. The life-cycle of bamboo varies in different species. Normally, new bamboos grow up from bamboo shoots at the roots. If the soil changed in humidity or nutrition that the plants find that difficult to grow, they will start to blossom. After the blossom, the flowers will give the fruit

LIFE CYCLE OF BAMBOO

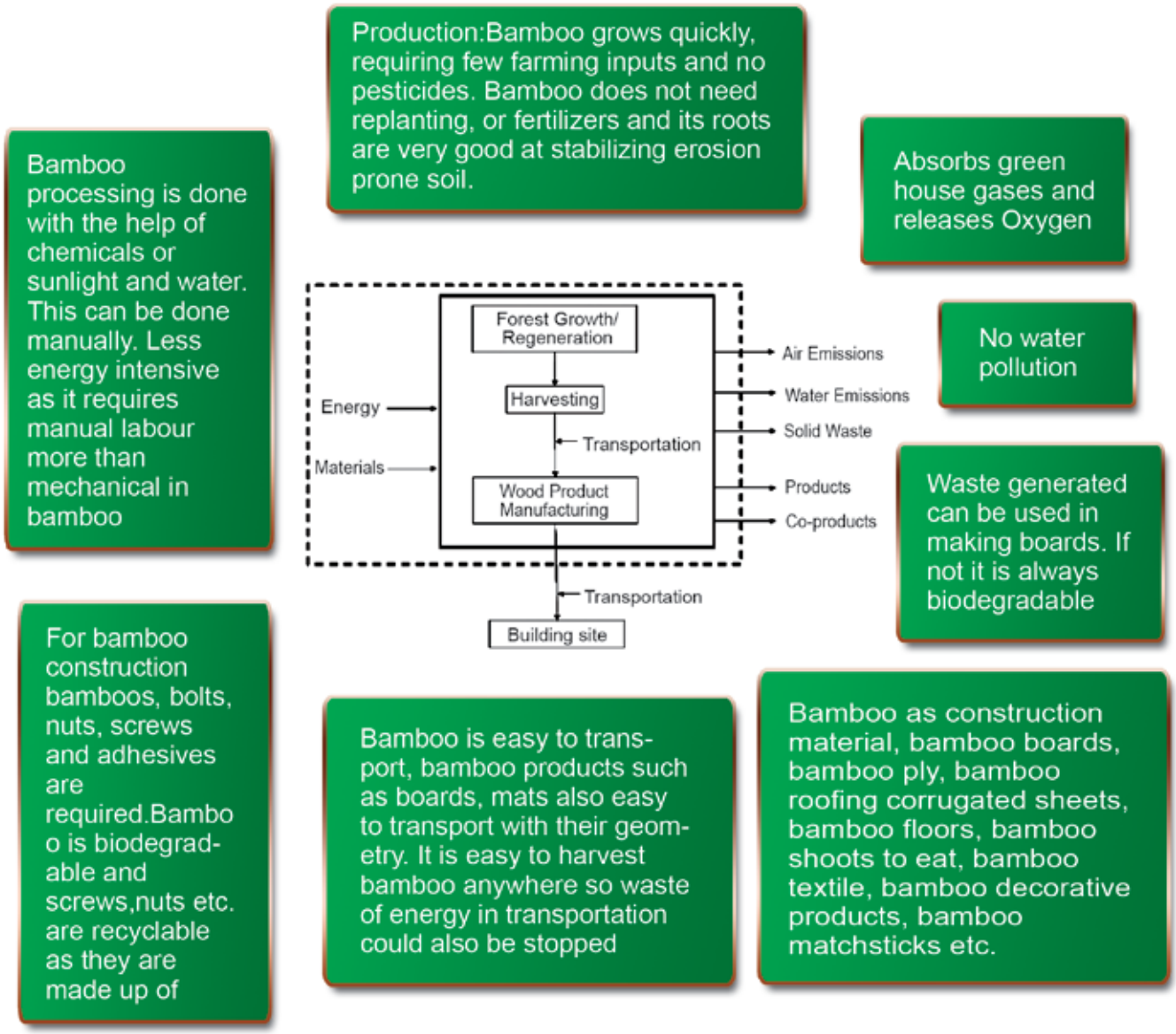
The net impact of bamboo on the environment throughout its life:

- Energy inputs: Less energy intensive. Human energy required is more than mechanical.Employment opportunities for rural people
- Renewable: Easily renewable. Matures in 3-4 yrs.Same roots can give more bamboos after cutting
- Wastes: Bamboo is a biodegradable material
- Environmental and Human impacts: Positive impacts Takes up greenhouse gases and emits Oxygen. Prevents soil erosion

The monopodial species grow horizontally over large distances. A rhizome stolon will grow in length by 1 - 6 m per annum with an average life span of ten years. At irregular intervals the lateral buds produce single cane stems from which new canes grow upwards. These species can be found in subtropical regions with a temperate climate

The sympodial species develop horizontaly over short distances growing in a circular spreading pattern by 1 -3 rhizome bulbs per original rhizome. Their points bend upwards and allow the new cane to mature. These species are characteritic of the tropics.

Several root systems can penetrate and overlay each other, resulting in cumulative root stolon. The bamboo root network thus forms a supremely effective protection against erosion, it delays the draining and soaking-away of rain water and thus serves as a moisture store.

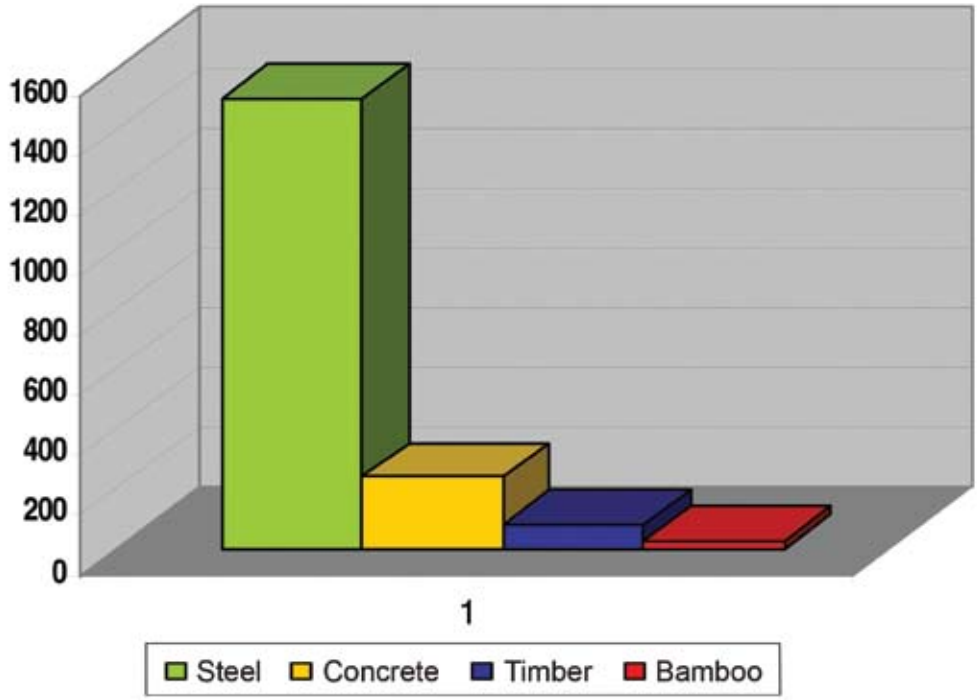


System boundary (dotted lines) for cradle-to-gate analysis of the production of bamboo in construction

ENERGY REQUIREMENT OF CONSTRUCTION MATERIALS

Materials	Energy for production MJ/Kg	Weight per volume Kg/m³	Energy for production Kg/m³	Stress when in use	Energy per unit stress
Concrete	0.8	2400	1920	8	240
Steel	30	7800	234000	160	1500
Wood	1	600	600	7.5	80
Bamboo	0.5	600	300	10	30

Source: Prof.J.A.Janssen, Eindhoven University, The Netherlands



Energy Consumption in Different materials during Fabrication in MJ/M3 per N/MM2

Bamboo is one of the strongest building materials. Bamboo's tensile strength is 28,000 per square inch versus 23,000 for steel. In the tropics, it is possible to plant and grow your own bamboo home. In a plot 20m x 20m, in the course of 5 years, two 8m x 8m homes can be constructed from the harvest. Every year after that the yield is one additional house per plot.

Material	Working Stress N/mm Sq	E N/mm sq	Working Strain in Joule -6	Strain Energy Stored	
				Joules /m3	Joules/kg
Concrete	8	25000	300	1200	0.5
Steel	160	210000	800	64000	8.2
Wood	7.5	11000	700	2600	4.3
Bamboo	10	20000	500	2500	4.2

EFFICIENCY OF MATERIAL FOR STRENGTH AND STIFFNESS

Material	Working Stress/Density	E/Density
Concrete	8/2400 = 0.003	25000/2400 = 10
Steel	160/7800 = 0.020	210000/7800 = 27
Wood	7.5/600 = 0.013	11000/600 = 18
Bamboo	10/600 = 0.017	20000/ 600 = 33

EFFICIENCY OF MATERIAL ACTING AS COLUMN

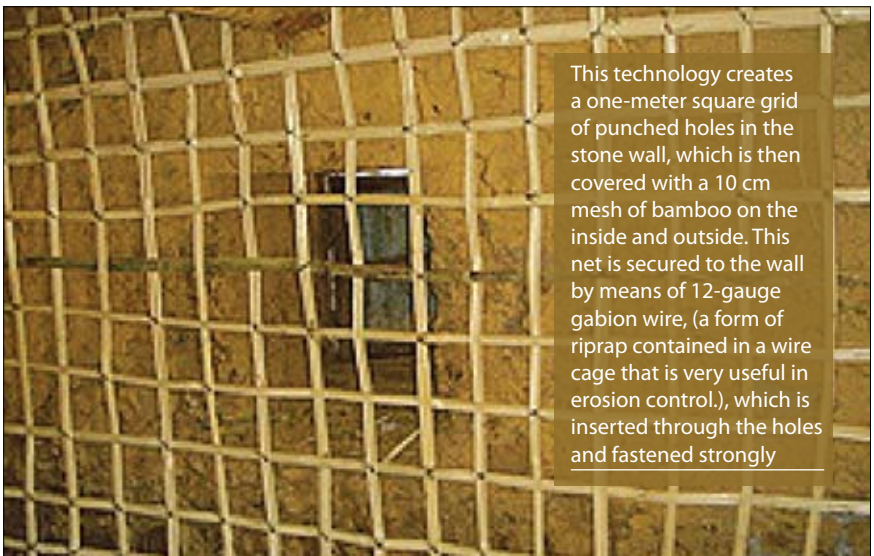
Material	√E Weight by Volume
Concrete	0.07
Steel	0.06
Wood	0.17
Bamboo	0.24

Bhungas are like boon of nature to the residents of Bani west, which is a desert area. Sand blows in the winter and makes life miserable of the people; it is only Bhungas, which gives protection.

BAMBOO A BOON FOR EARTHQUAKE RESISTANT CONSTRUCTION

Kutch with its enterprising people ,hostile geography, colourful history, diverse society, rich traditions, indigenous architecture, has a tradition of incredibly beautiful crafts, which form an essential part of its habitat. The architectural forms developed in this highly earthquake prone area are invariably developed in harmony with the climatic conditions in addition to the earthquake resistant features. The circular or semicircular form and low rise load bearing structure of these houses called "Bhungas" enable them to withstand the lateral movements developed on earthquake occurrence.

Traditionally they are made of mud with wooden reinforcement in the form of tree branches and ropes. Bhunga is also made of Bamboos. They are different than wooden one. Foundation for bamboo Bhungas are made of cement and stone raised up to plinth level. Bamboo strips are tied together with nut bolts to make a strong wall. The roof is made of wooden top dome where bamboo sticks are fixed with a thick layer of grass put on roof and securely tied together. The Walls are also made of bamboos sticks and layer of grass is tied with it. Mud and cow dung is used for wall plaster put on grass walls. Such plaster is applied on rooftop also. Flooring can be done using cement/tiles etc. as per requirements. The different designs of Bhungas are having different utilities also. Kutch region is having different atmosphere than rest of Gujarat. It is very hot in summer and too cold in winter. When sun heat is at its peak, Bhungas due to their insulated material creates cool environment insite. Bhungas withstand all natural calamity like earthquake, cyclone etc. Thus Bhungas are special multi advantage housing shelters of Kutch regions.



This technology creates a one-meter square grid of punched holes in the stone wall, which is then covered with a 10 cm mesh of bamboo on the inside and outside. This net is secured to the wall by means of 12-gauge gabion wire, (a form of riprap contained in a wire cage that is very useful in erosion control.), which is inserted through the holes and fastened strongly

BAMBOO FOR RETROFITTING

Nepal's Institute of Engineering's Center for Disaster Studies has developed a retrofitting technology for rural houses in Nepal. Ninety percent of Nepalese houses are made of stone and unfired bricks. Innovative technology developed by the research would make each house earthquake resistant for a direct cost of U.S.$20-30.

It is covered with a stucco of mud, which is used in rural areas in order to ensure longer life for the bamboo mesh. The direct cost is only of the gabion wire, because bamboo and mud are available locally. The technology is also very simple and can be used by villagers. In Nepal, the Village Development Committees distribute gabion wire to the villagers when they are threatened by flash floods of rivers.

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Photograph: Courtesy the Authors.