

# **Bamboo Symphony**

## **An Exploration in Bamboo**

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### **ABSTRACT**

The creation of 'Bamboo Symphony' by the Indian Architectural Firm Manasaram Architects clearly indicates a comprehensive approach towards sustainable architecture. A close study of the use of bamboo in this project adds to research going on all over the world with respect to this material. 'Bamboo Symphony' is a comprehensive effort to emphasise the inherent strength and flexibility of the material, highlighting its high scientific credentials and simple applicability; all leading to the realisation that bamboo can prove to be a startling replacement for the modern vocabulary of steel, aluminium and glass.

The project has been awarded the third prize at the Lafarge Invention Awards in 2011 for its innovative structural system besides being shortlisted for the coveted World Architecture Festival Award 2011.

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## INTRODUCTION

Bamboo's market capitalisation is \$10 billion and this is expected to double in five years (WBO, 2012). However, this stealthily emerging eco friendly material is still threatened by new construction standards (INBAR, 2012). The material has come out of the shadow of being a 'poor man's timber' and is gradually being accepted globally as a high-end wood product (WBO, 2012). Its many advantages include its strength (twice that of steel), a weight to strength ratio (far better than most modern materials), a solid internal stiffness and its property of cleansing the air by virtue of its high carbon fixing capacity (Virmani and Rawal, 2012). Nicknamed the 'timber of the 21st century', bamboo is ready to be harvested annually and sustainably after four to five years, in contrast to typical tropical hardwoods that take many more years to mature and can only be harvested once (BBC, 2012).

Throughout the world Bamboo is taking on new roles, architecturally it is being used in rural and suburban areas, in prefabrication and high-end structures (NMBA, 2012). In India bamboo is also being used in multi-various products including bamboo bicycles and bamboo charcoal soaps (ABC, 2012). India is also gearing up for its first bamboo park in Tripura with the idea being to expand industries, based on this produce (Deccan Herald, 2012).

It is in this context that the study "Bamboo Symphony" has been conducted, exploring numerous applications of the material. The Bengaluru based Manasaram Architects are adept at exploring local materials and traditional technologies and have gained their expertise in bamboo buildings over many years (Manjunath, 2012). Strongly advocating its use is the firm's Principal Architect, Neelam Manjunath, who's recent experimentation with the material has led to 'Bamboo Symphony' - her 2260 sq ft office on the outskirts of Bengaluru.

## PROJECT FEATURES

Within a tight budget the project is a zero energy development using recycled wood and bamboo, stone boulders, in-situ mud blocks, fly ash, scrap metal and debris from neighbouring construction sites (Ref figure 1). Bamboo features throughout the project: as a bamboo crete walling system with precast wall panels, bamboo columns and beams, bamboo fibre in the concrete roof (reducing its weight), with bamboo splits used as reinforcement and bamboo rings in the cement flooring and partitions. It also features in the interiors; in the understated furniture (tables using 15mm bamboo matt and sofas), garden lights, other artefacts including lampshades (Ref Figure 2). In the bamboo crete walling system (that can be constructed in-situ or produced as panels off-site) a grid of bamboo splits at 6" centres forms the reinforcement for a concrete wall to which chicken-mesh is tied, this is then plastered from both sides. The raw and rustic ambience created through the aura of bamboo induces tranquillity throughout the space (Bamboo Symphony, 2012).

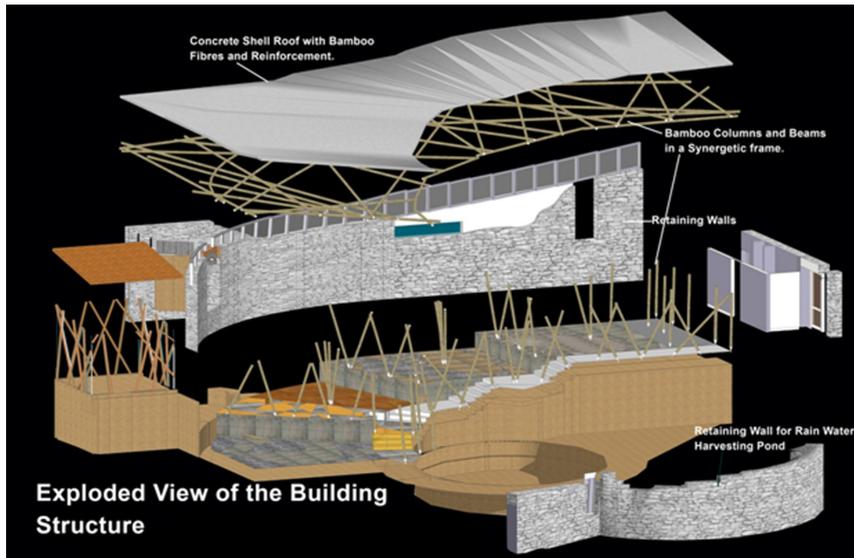


Figure 1: The structure makes use of recycled wood and bamboo, stone boulders, in-situ mud blocks, fly ash, scraps metal and debris.



Figure 2: Bamboo features throughout the office in myriad applications.

The structure, based on a fisherman's net structure, seems to emerge out of the landscape; such is its seamless bonding with nature (Bamboo Symphony, 2012). While random rubble masonry forms the foundation with mud blocks forming a curved retaining wall, a concrete shell roof (made on site) forms the canopy and drapes over the structure supported on bamboo columns & beams --all very agreeable to the eyes. (Ref Figure 3).

"Structures similar to these, on account of their homogenous load distribution, have been found to be highly efficient requiring minimal energy and material usage in nature. Bamboo happens to be the only natural building material with the lowest energy balance that classifies for these structures. Utilisation of bamboo for grid matrix structures (on account of its flexibilities) or in high-tech composite materials with high tensile strength, is a trend that can completely wipe out all the other so called 'energy intensive high tech materials' from the construction market", avers Manjunath (Personal Communication, 2012, Bengaluru).

Figure 3: The concrete shell roof draping on the structure is the highlight of the Bamboo Symphony.



The crafted interiors in the free flowing structure have been divided into levels comprising the reception, waiting lounge, architect's cabin, a board room, a computer room and a studio (Bamboo Symphony, 2012) (Ref Figure 4). The office curves into a spiral leading down to a lotus pool which is used for storing rain water for humidification of the surroundings, in order to prevent the bamboo columns and beams from cracking when the humidity goes down (Ref Figure 5). Excess rainwater is used for recharging the bore well, which takes care of the water requirements of the structure. The earth excavated from this pond has been used for mud plastering of the bamboo crete walls (Ref Figure 6). Nature gets directly invited into the structure in the absence of any doors or windows. Big boulders near the pond have been excavated from the site, and a green wall with growing ivy creepers provides a rocky natural landscape (Bamboo Symphony, 2012) (Ref Figure 7).

Designed as a hybrid of synergetic and tensegrity structures (Personal Communication, 2012, Bengaluru), the structure's bamboo columns (split into separate bamboo culms) as opposed to deceptive abstract placements have been calculated for position, size and inclinations (Ref Figure 8). The synergetic tensegrity structural system was designed by making study models, and larger mock-up models. Before the final construction, a 1:1 scale test structure was erected with old discardable bamboos and physically tested for its strength and stability by loading with two men walking on the frame (Ref Figure 9 & 10) following which, the deflections were noted and the inclinations of the columns were adjusted before the final concreting (Personal Communication, 2012, Bengaluru). The flooring pattern is a reflection of the bamboo beams overhead – bestowing a magical three-dimensional feel to the space (Bamboo Symphony, 2012). The bamboo culms on the external area beyond the walls have grouted in stones (Ref Figure 11).

Having worked with alternative concepts for a long time, Manjunath discovered the various unexplored facets of bamboo in 1999 and appreciated its 'unparalleled quickness with which things could happen with it' (Personal Communication, 2012, Bengaluru). Her proficiency in the material is due to the amount of research she has conducted on it. "Every time I work with bamboo, I am amazed by its endless possibilities and hence look at every new bamboo building as a challenge to discover



Figure 4: The various functional areas in the office are segregated through levels.

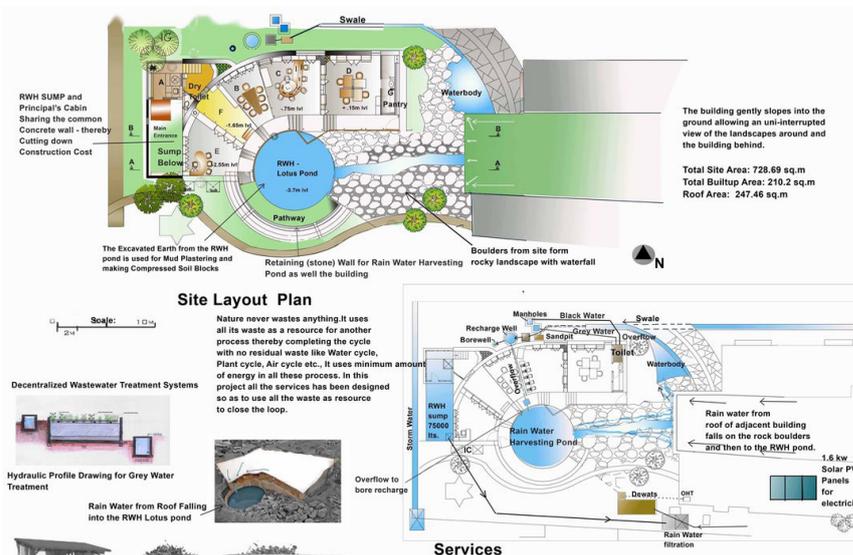


Figure 5: The Lotus Pond aids in Rain Water harvesting.



Figure 6: The excess rain water from this pond takes care of the water requirements of the office.

Figure 7: The rugged exterior terrain compliments the structure.



Figure 8: The criss-crossed bamboo columns hold the fabric roof.





Figure 9: The testing process of the 1:1 mock-up structure.



Figure 10: The testing process of the 1:1 mock-up structure.

Figure 11: Bamboo culms holding the roof beyond the walls are grouted in stones.



something new about the material. The challenge with bamboo is that people have half baked knowledge about it”, she states (Personal Communication, March 2012, Bengaluru).

The joining of two bamboo beams is done with bamboo dowels and the gaps are filled with bamboo dust and a suitable bonding material. The bamboo columns transfer the load to the ground through 1” MS bolts and the joints are filled with concrete (Bamboo Symphony, 2012). Bamboo faces challenges in its joinery details that arise out of bamboo’s non-uniform diameter, its maximum usable length of 8m, and it’s tendency to split (Nghia, 2012, Pg 28). Casting a roof was thus a challenge where joints had to be filled up in order to maintain a uniform thickness of the slab. The one challenge that still exists with bamboo throughout the world, which Manjunath is experimenting with, is the material’s discolouration on exposure to sunlight (Personal Communication, March 2012, Bengaluru).

Sustainable features of the Bamboo Symphony include an extensive rainwater harvesting system with a 75,000l sump sharing a common concrete wall with the principal cabin (leading to lowered construction costs), special water conserving installation and fixtures, complete natural ventilation, a 1.6KW solar energy system and utilisation of the building mass as thermal storage as part of a heat strategy achieved via passive cooling. A complete wall made up of bamboo frame and rings helps cross ventilation. The orientation of the structure lets the dry breeze pass over the roof fabric while the cool south breeze flows through it (Personal Communication, March 2012, Bengaluru) (Ref Figure 12&13). Innovations include simple plumbing pipes in the roof admitting daylight and inverted bamboo lampshades masquerading as CFL holders (Bamboo Symphony, 2012).

**ANALYSIS**

The perception of bamboo, the world’s fastest growing plant, is undergoing a transformation. Bamboo Symphony goes back to the roots of sustainable architecture that started with bamboo. The material has an immense potential that still needs to be completely tapped, especially for people dependent on the material for their livelihood (ARCBR, 2012). The project also validates the material’s use in a tropical savannah climate where bamboo is grown locally. The project authenticates bamboo’s innate strength as a structural element, its innumerable uses and diverse applications all attained at a low cost. While the average building construction cost in Bengaluru comes to around Rs 1200/sq ft, this project was achieved at Rs 830/sq ft – a remarkable achievement. The innovations with the structure and the material are fascinating; including that of a light structure crowned with a heavy roof as opposed to the general methodology of light roofs resting on heavy supports.

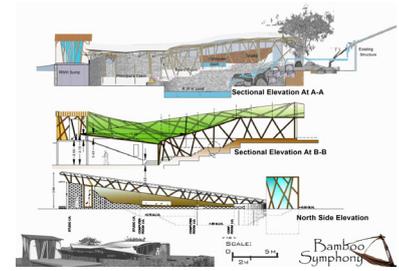


Figure 12: Few cross sections through the structure.

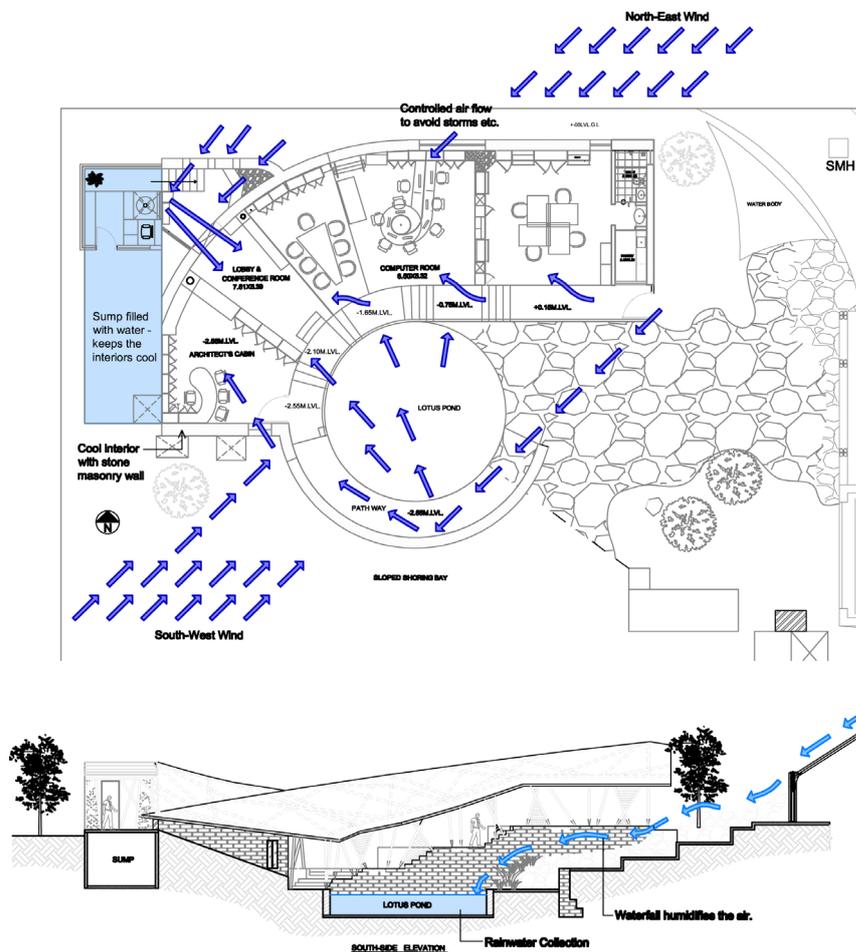


Figure 13: Aspects of Passive Design and Sustainability incorporated in the design.

Through the project, research has been initiated on a construction system comprising of a structure based on traditional fishing platforms and web systems in nature, and also on a ‘bamboo reinforced concrete roof’ with a concrete mix modified with bamboo fibres which in cost came out to be 40% lower than the average RCC construction costs (Personal Communication, March 2012, Bengaluru). This possibility/flexibility has

been achievable due to the fact that bamboo is the only natural material that can replace steel in many applications. This has been proved in Bamboo Symphony where bamboo has replaced steel and concrete for columns and beams and steel as reinforcement in the slab (Personal Communication, March 2012, Bengaluru). The project investigates the traditional Indian way of working with bamboo and concentrates on the 'doing more with less' technique with regard to the number of bamboos employed. The free form roof with bamboo reinforced concrete is a novel departure from the routine use of highly processed materials. This corroborates the fact that contemporary buildings with mud and bamboo are possible at a fraction of the cost of its urban counterpart and can be constructed by unskilled labourers with very simple construction methods and tools (Personal Communication, March 2012, Bengaluru). This study contextually comes at the right time; when the Environment Ministry in India is recommending bamboo based houses (Hindu, 2012).

### **ACKNOWLEDGEMENTS**

Photograph source: architect Neelam Manjunath; photographer, Krishnau Chaterjee

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