

# Bambooklet: A Guide to Bamboo

**Marta Anna Nowak**

AN.ONYMOUS

**Iman Ansari**

AN.ONYMOUS

Bamboo is an exceptional material. It can grow in almost any climate, but it is native to the tropical and sub-tropical areas. Although it is a very light material, bamboo is stronger than steel in tension, and more resistant than concrete in compression. Bamboo can be used at any stage of its growth, from early stages as a food, paper, and clothes, to its later stages for furniture, scaffolding, and finally as a building material.

As a plant, bamboo has remarkable ecological properties. It grows naturally without requiring fertilizers or pesticides, and it can capture carbon from the atmosphere and release 35% more oxygen than equivalent stand of trees. Additionally, because of its high nitrogen consumption, bamboo roots help mitigate water pollution by removing toxins from contaminated soil. And because bamboo regenerates within only two to three years - compared to trees that can take up to 10-20 years - it can serve as an alternative material to wood. In addition to its unique material characteristics, bamboo performs exceptionally well and survives under extreme conditions, such as fire, earthquake, cyclone, and even nuclear blasts, but also has the ability to prevent earth erosion, water run off, and mud slides.

But above all, bamboo is a highly sustainable material, not only because of its exceptional ecological properties, but also due to its socio-economic value. Because of its rapid growth, harvesting bamboo can be quite frequent and the return on investment comes much quicker. As a result, bamboo plantation projects are economically more appealing especially for farmers with little capital. In addition to that, because of its lightness and ease of handling, bamboo can serve as a social agent in creating jobs and empowering women in under-served communities.

Today, the complex nature of our problems - climate change, scarcity of our resources, and rapid urbanization - require a transdisciplinary approach. We need to re-think housing models, neighborhood typologies, energy and infrastructure, mobility and transportation, and finally building materials and construction technologies. In fact the building and construction industry is a major contributor to climate change and a key player in sustainable development. According to the International Energy Agency, buildings account for up to 40 percent of the total consumption of energy. But oftentimes a small-scale change, such as exploring materials and construction technologies, can have a larger impact on potentially addressing some of the pressing issues of our time.

But despite all this, we still know relatively very little about bamboo. There are over 1500 species of bamboo worldwide, yet the theoretical knowledge and practical application of bamboo have largely remained localized and have not been disseminated. Our research presents itself as a guidebook, which provides the basic introduction in using bamboo, and combines the contemporary knowledge on plantation, harvesting, treatment, and handling of bamboo, together with its application in construction and design. "BAMBOOKLET" promotes the application of bamboo as an ecological as well as socio-economic agent for sustainable growth and development in low-income communities especially in the tropical and sub-tropical areas worldwide.

# BAMBOOKLET

## A GUIDE TO BAMBOO



### INTRODUCTION

<b>BASICS</b> 	<b>TAXONOMY</b> 	<b>ANATOMY</b> 	<b>APPLICATIONS</b> 	<b>BUILDING MATERIAL</b> 
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### THEORETICAL IMPLICATIONS

<b>ECOLOGY</b> <p>The ecological advantages of using bamboo seem endless. Bamboo can capture carbon from the atmosphere and release it with the oxygen at about 4000 pounds of carbon per hectare per year. It starts release 30% more oxygen than equivalent stand of trees.</p>	<b>ECONOMY</b> <p>Harvesting bamboo can be quite frequent, and therefore return on investment comes quickly. As a result, bamboo community forestry projects are economically more attractive, especially for small farmers with little capital.</p>	<b>FLEXIBILITY</b> <p>Due to its longitudinal fibers, freshly cut bamboo are very flexible. Although, after drying and treating, bamboo becomes generally rigid, and the rigidity increases with larger diameter of bamboo. It is still used as an earthquake resistance agent.</p>	<b>DURABILITY</b> <p>A bamboo house will last as long or longer than any conventional wood framed building. In Japan, bamboo structures have a history of lasting 200 years. In Vietnam, bamboo structures built with untreated bamboo poles are over 50 years old.</p>	<b>LIGHTNESS</b> <p>Bamboo is relatively a very light material - especially because of being hollow. The quality of the material makes transportation much easier and more energy efficient. It also splits easily by weaving and is thus easy to handle even for women.</p>																								
<b>SOIL STABILIZING</b> <p>The extensive rhizome network stabilizes the soil, prevents it from erosion and reduces soil compaction and hardening. The root systems may also prevent a water runoff and can hold up to keep on much water in the waterbeds.</p>	<b>FIRE RESISTANCE</b> <p>Bamboo has a high content of silica in the outer skin and high density which make it a good fire resistant material. Bamboo's fire resistance can also be increased by filling the cane with water.</p>	<b>EARTHQUAKE RESISTANCE</b> <p>Bamboo is an extremely resilient material. Bamboo joints managed to survive the nuclear blast at Hiroshima at a point closer to ground zero than any other life form.</p>	<b>STRENGTH &amp; STABILITY</b> <p>Bamboo is considered among the greatest building materials, since it is strong both in tension and in compression. In structural tests, bamboo showed a higher tensile strength than many alloys of steel, and a higher compressive strength than many mixtures of concrete.</p>	<table border="1"> <thead> <tr> <th>Material</th> <th>Tensile</th> <th>Compressive</th> <th>Modulus (E)</th> </tr> </thead> <tbody> <tr> <td>Bamboo</td> <td>200</td> <td>100</td> <td>11000</td> </tr> <tr> <td>Concrete</td> <td>40</td> <td>40-50</td> <td>30000</td> </tr> <tr> <td>Steel</td> <td>400</td> <td>250</td> <td>200000</td> </tr> <tr> <td>Aluminum</td> <td>100</td> <td>70</td> <td>70000</td> </tr> <tr> <td>Timber</td> <td>100</td> <td>40</td> <td>10000</td> </tr> </tbody> </table>	Material	Tensile	Compressive	Modulus (E)	Bamboo	200	100	11000	Concrete	40	40-50	30000	Steel	400	250	200000	Aluminum	100	70	70000	Timber	100	40	10000
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### PRACTICAL APPLICATIONS

<b>GROWING &amp; HARVESTING</b> <p>Improperly harvested bamboo, regardless of the species, can survive only between 2 to 5 years before being obliterated by insects. Overlooking the fundamental issue can cause rapid deterioration of the buildings.</p>	<b>TREATMENT</b> <p>Bamboo that is not treated will be destroyed by insects in a short period of time. The decision of not treating the bamboo before construction can turn out costly in a long run.</p>	<b>DRYING &amp; HANDLING</b> <p>One of the reasons most questions on bamboo cuts is because the culms were not dried properly. Drying bamboo is as crucial as proper harvesting and treating of bamboo. Once bamboo is dried, it becomes more stable than wood.</p>	<b>EDUCATION &amp; TRAINING</b> <p>The minimum training should enable people to avoid some basic mistakes in bamboo construction. Standards about building with bamboo are still missing, which impedes application and use of bamboo in countries with strict regulations.</p>	<b>COMMUNITY ENGAGEMENT</b> <p>Due to economic decline and promotion, bamboo has started to become a contemporary popular and highly marketable material. Since bamboo products have come into the market, the image of bamboo as a "poor man's material" is being transformed to one that is contemporary and trendy.</p>
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#### JOINTS, CONNECTIONS AND GOOD PRACTICES

### PROJECT PROPOSAL: BAMBOO ROOF MACHINE

**REGIONAL CONCERN**

The tropical conditions of the subtropical region require different formal and structural systems in building development. Heavy rains and sunlight are among the typical characteristics of the region, which urges a different strategy in building development. Among the most crucial aspects are roofs and coverings. With the growing concerns on issues of sustainability and global warming, it is important to rethink different ways of ventilating and shading, as well as conserving and producing energy in the building. The building takes full advantage of the energy with the roof machine. It uses the sloping roof for shading, which essentially roots down the space. It also collects the water from the rain and directs it to an area for proper use. The form of the structure along with the shading will allow of a cooling system which direct the wind from the angle in and out of the building. This system becomes even more effective when it rains since the roof structure is also filled with water.

**ROOF MACHINE**

The idea of roof machine was invented after series of analysis on the natural conditions of the tropical areas, and the characteristics of bamboo as a potential structural material. The aim was to design a natural mechanical roof that can protect the space from sunlight and rain, and at the same time collect water and allow for ventilation. The roof machine consists of series of bamboo cut in half, which are then inserted offset and coupled. The pieces are then connected by a simple joint that allows circular movement of the pieces. A long piece of metal connects the joints through the piece and reaches the bearing wall. These are rails placed inside the wall which allow the roof to move in either direction. The area also consists of a channel for collecting and removing the water from the roof.

**BAMBOO SYSTEMS**

As sustainable material, bamboo can serve different functions both formally and structurally. The internal structure of the material can serve as a water barrier or container, as it did in the Roof Machine. However, the external structure of the material as a strong linear material can be used for different purposes. The Bamboo pieces can be connected to each other from the ends through a system of joints which will allow entire rotation and heading. The joint can connect up to six different Bamboos together. The system can form a structural skin, and grass in different directions. The system can also be used as a space frame.