

# Bamboo- An Alternative Building Material

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**Abstract** – The main objective of the paper is to create awareness among the civil society on bamboo as an alternative building material. Bamboo has its unique advantages as a building material and can be easily cultivated and harvested in a relative short time but unfortunately it is not used as a building material. This paper discusses the potential of bamboo and possibilities of use of bamboo in construction industry.

**Key Words:** bamboo, building material, properties, sustainable material.

## 1. INTRODUCTION

The global buildings sector is growing at unprecedented rates, and it will continue to do so. Over the next 40 years, the world is expected to build 230 billion square metres in new construction – adding the equivalent of Paris to the planet every single week. This rapid growth is not without consequences. While buildings sector energy intensity has improved in recent years, this has not been enough to offset rising energy demand. Buildings-related CO<sub>2</sub> emissions have continued to rise by around 1% per year since 2010, and more than four million deaths each year are attributable to illness from household air pollution.[2] Bamboo has been widely known as a sustainable building material due to some reasons among others are bamboo can be easily cultivated and harvested in a relative short time and can be reused. Bamboo as building materials is easy to bend and lithe. Bamboo is considered as cheap and non-permanent materials. It is also considered as low-class material, even called as “the poor man timber” by many modern builder (Lobokivov, 2009). People tend to choose brick, concrete and steel as structural and construction materials for modern building. But nowadays, after global warming and sustainability issues are emerged, bamboo as building materials is widely discussed and reviewed. Some architect and builder nowadays tend to choose bamboo for building material. [1]

### 1.1 Potential of bamboo

As construction material, bamboo has a very strong fiber. The compressive strength of bamboo is two times higher than concrete, while the tensile strength is close to steel. Bamboo fiber has a shear stress that is higher than wood. Bamboo has wider span than wood. Bamboo also can be curved without breaking. Bamboo is considered as one of building materials that are very strong with tensile strength

more and less than 28,000 N per square inch, compared to steel which is 23,000 N per square inch. [2] Bamboo is fastest growing plant. Bamboo has highest carbon dioxide absorption. It has continuous absorption of carbon dioxide and release of oxygen. Quick harvest is possible which can be also continuous harvest.

### 1.2 Properties of Bamboo

**Tensile strength:** The fibers of the bamboo run axial. In the outer zone are highly elastic vascular bundles that have a high tensile strength. The tensile strength of these fibers is higher than that of steel.

**Shrinking:** Bamboo shrinks more than wood when it loses water. The canes can tear apart at the nodes.

**Fire resistance:** The fire resistance is very good because of the high content of silicate acid. Filled up with water, it can stand a temperature of 400° C while the water cooks inside

**Strength Compressive:** The portion of lignin affects the compressive strength. Whereas the high portion of cellulose influences the buckling and the tension strength, because it represents the building substance of the bamboo fiber.

**Elastic modulus:** There exist an perfect relation of the cross section of the tube, if you fall below or above it the elastically modulus decreases (the higher the elastically modulus of the bamboo, the higher is the quality). Like the elastically modulus of solid wood the one of bamboo also decreases 5 to 10% with growing stress. The enormous elasticity makes bamboo to be a very useful building material in areas with high risk of earthquakes.

**Flexural (bending) strength:** Where a deflection in the construction was unavoidable and annoying, one could bend the recently harvested tubes so that you get a super elevation, which later will be compensated under the working load.

**Shearing strength:** Especially for the construction of the bamboo tube joining it is important to consider the shearing resistance. The influence of the distance of the shearing surface decreases with growing length of shearing surface. [3]

## 2. Bamboo structures in the world

*Green school, Bali:* Green School is a school building built using bamboo as main structure materials. Initiated by John Hardy, the school complex building finally won Aga Kahn award in 2010. The school building is located in Bali, Indonesia, designed in 2006 and completed in 2007. The school complex consist of several masses which each mass accommodate different function such as classroom, laboratory, multifunction hall, office, student and teacher's dormitory, etc. The main building, located in the center, is two to three storage building. [1]

*Bamboe Koenig, Bali:* Bamboe Koenig (yellow bamboo) restaurant in Lodontuh, Bali, which recently received an award from FuturArc for using local material and worker. Designed by young architect, Effan Adhiwira, the restaurant has a circular plan with a circular stage in the center of the restaurant; therefore, the owner can perform a Balinese traditional dance on the stage. Its roof also has a circular and dynamic shape that make the building looks like a serpent. [1]

*Community building Poso, Central Sulawesi:* This unique building is built on land that is flooded every rainy season thus the construction process is conducted on the dry season. It has dynamic and twisting roof shape combination of synclastic and anticlastic curvature. The synclastic curvature roof shape serves as an envelope for multipurpose hall while the anticlastic curvature roof shape is for daily activities space, such as office and library. [1]

### 2.1 Bamboo Footings

For use as foundation, the bamboo poles are directly driven into the ground. Single post or strip footing and Bamboo for pile foundation are two methods in which foundation of bamboo structure is made. [3]

### 2.2 Bamboo Floors

Floors normally consist of bamboo beams fixed to strip footings or to foundation posts. The beams therefore run around the perimeter of the building. Depending on the form of floor decking, secondary joists, often taking the form of split culms may be required. Joist diameters are in the order of 70mm. Joist centers are typically 300 to 400mm, or up to 500mm if secondary joists are used. Split bamboo, flattened bamboo, bamboo mats and Bamboo Panels are the various types of floors in use. [3]

### 2.3 Bamboo Walls

The most efficient use of bamboo is that it is used in construction of walls and partitions. The major elements of a bamboo wall (posts and beams) generally constitute part of the structural framework. As such they are required to carry

the self-weight of the building and also loadings imposed by the occupants, the weather and, occasionally, earthquakes.

### 2.4 Roofs

The roof of a building is its most important component. It must be strong enough to resist the considerable forces generated by wind and roof coverings. In this respect bamboo is ideal as a roofing material as it is strong, resilient and light-weight. [3]

### 2.5 Bamboo Scaffolding

Since ancient times, bamboo poles have been tied together and used as scaffolding. The properties of bamboo such as resilience, shape and strength make it an ideal material for the purpose. The working platforms for masons can also be built of bamboo. [3]

### 2.6 Bamboo Reinforcement

Besides the use of bamboo as a building material, there have been proposals to use bamboo as reinforcement in RC columns, beams and slabs. One of the examples is a silo made of bamboo-reinforced concrete. This is the avenue for further research in the process of combining the ancient of bamboo building with modern materials like concrete. [3]

## 3. Advantages of bamboo

- Bamboo is a light weight, strong and versatile material to be used for construction.
- It can be transported and worked with it easily.
- It is Environment friendly.
- It is accessible to the poor.
- Bamboo has a higher tensile strength.
- It is self-renewing resource.
- It grows rapidly after once harvested.
- Bamboo is highly productive.
- Use of bamboo will reduce deforestation.
- Bamboo is a composite and flexible material.

## 4. Disadvantages of bamboo

- Bamboo requires preservative treatment and if not treated well it get attacked by the fungi.
- Bamboo has less durability.
- Bamboo should be used as it is available in shape as given by the nature.

- There is lack of sufficient design, guidance and codes.
- Bamboo does not lend itself to being painted because of its waxy coating.
- Bamboo does not bear weight width-wise. It can bear weight only along its length wise (height-wise).

## 5. CONCLUSION

For a long time bamboo has been known as “poor man’s timber”, so it is being used for cost effective housing or low cost housing. Now a day, due to its various applications and properties of bamboo, it can be used as an alternative building material in construction industry. Bamboo is lighter in weight and stronger than steel. Bamboo has good tensile strength and hence also can be used as a building material in organic shaped buildings. Bamboo has certain unique features such as high growth rate, earthquake resistant properties etc. But as it gets decay it is not used as a building material and thus used to make handicraft items and tools only. Using proper preservative treatment methods bamboo can be used as a building material.

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