

Bamboo as a Green Building Material: A Comparative Analysis

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Abstract

Bamboo is a valuable resource plant that influences the function and health of terrestrial ecosystems, as well as human society's safety and well-being. Bamboo is a centuries-old solution to a modern challenge. Bamboo is a viable alternative to today's common building materials, such as wood and steel. One of the major characteristics that makes bamboo an efficient construction material is its high tensile strength, which is significant compared to mild steel at yield point, as well as its excellent weight strength ratio, which makes it very robust to the pressures caused by earthquakes and hurricanes. Housing is one of the most important priorities, and with the current housing shortage, contemporary administrative officials around the world are struggling to find a solution. Among the current materials in use, bamboo seems to be the most beneficial. Bamboo building construction employs a structural frame methodology based on traditional timber frame construction and design. This study examines a number of studies that have been conducted on bamboo as a construction material.

Keywords: Bamboo; Green building material; Green Gold; Sustainable Development.

1. Introduction

Bamboo is a grass with aliases like "poor man's timber," "Green Gold," and "Cradle to Coffin" due to its wide range of applications.[1] Bamboo is widely regarded as a long-lasting, fast-growing, and low-cost raw material. India is a nation with the most bamboo. India has a large bamboo potential, with 14 million ha of bamboo forest. India is the leading country when it comes of bamboo resources.[2] In effort to match India's growing population's housing needs, the country is anticipated to confront a timber shortage in the next years. Furthermore, the rising reliance on traditional materials is blamed for environmental damage. Both of these factors have prompted consideration of using bamboo as a substitute for wood and steel, as it is a highly renewable and environmentally friendly material. The growth of bamboo in construction and structural applications has been aided by technological advancements and initiatives undertaken by the central and state governments. New bamboo jointing, protection, and preservation technologies have been developed, resulting in increased durability and quality, as well as new applications for bamboo as a wood substitute. Traditional bamboo culm used in rural dwellings may now be turned into new and inventive bamboo-based goods employing cutting-edge technology and employed in high-end homes for roofing, flooring, doors, and windows, among other applications.

2. Literature Review

Nurdiah E. et al. (2016) : They explored how bamboo is used in organically curved buildings in their study report. Numerous case studies were used to explain the relation between structure, joint system, shape, and construction, all of which classified how bamboo is coiled into an organic shape.[3] According to the research results, bamboo could be a feasible construction material for organically curved structures, as well as a credible option to steel and concrete.[4]

Md Ahsan Sabbir et al. (2011) : The goal of this study was to see if bamboo might be used as a potential reinforcement in a concrete beam to compensate for the concrete's poor tensile strength. They performed a tension test on a bamboo specimen. The first three completed bamboo specimens were examined in their natural state (without treatment). Then, five completed bamboo specimens were examined with GI wire spirals at the ends for better gripping. The stress-strain curve for bamboo reinforcement was used to calculate the tensile strength, proof strength, and modulus of elasticity.[5]

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Manandhar R. et al. (2019) : They discovered that bamboo is frequently associated with sustainable practices during their research, however the explanation for this was not immediately evident. Furthermore, while the seismic attributes of bamboo housing have been widely investigated both conceptually and empirically, research on bamboo as a building covering is entirely lacking. More studies need to be done to fully comprehend the socioeconomic impacts of bamboo-based construction materials.[6]

Adekunle P. Adewuyi et al. (2015) : This study compared the flexural effectiveness and deformation characteristics of concrete elements reinforced with bamboo (*Bambusa vulgaris*), rattan (*Calamuc deerratus*), and twisted steel rebar. The yield strength (YS), ultimate tensile strength (UTS), and elongation of 50 specimens of the three materials were measured using a universal testing machine. They concluded that bamboo bars are suitable for non-load bearing and lightweight RC flexural constructions[7], however, for stronger interfacial adhesion and load-carrying capability, that rattan requires more pre-strengthening treatment.[8]

Bagchi S. et al. (2018) : They found in their research that bamboo is a good building material because of its great strength and low cost. Bamboo's drawbacks can be mitigated if safeguards are taken. Before employing it as a structural material, it is necessary to conduct tests on the specific bamboo species to determine its properties, as bamboo types range from place to place and hence the attributes of different bamboo vary.[9]

3. Bamboo Structural Shapes as a Building Material[10]

Bamboos are managed in such a way that they develop into the appropriate forms and structures:

- By compressing the developing stalk of bamboo within a square section, a squared cross-section may be created.
- Bamboo arch forms can also be made by squeezing the bamboo's growth into the desired shape. This would be less expensive than creating the same shape with regular wood.
- Traditional techniques such as applying heat and pressure to bamboo allow for curved and flat designs.



4. Properties of bamboo as a construction material[11]

- Compressive Strength of Bamboo

Bamboo has a higher compressive strength. The compressive strength of bamboo tubes is higher in the slimmer tubes.

- Tensile Strength of Bamboo

Bamboo has higher tensile strength than compressive strength. The fibres included in bamboo runs are really very elastic and have a high tensile strength.

When compared to steel, these fibres have a higher tensile strength.

- Elastic Modulus of Bamboo

One of the most essential qualities of bamboo is its elastic modulus. The higher the elastic modulus, the higher the quality of the bamboo.

The elastic modulus of bamboo is affected by the concentration of strong fibres in the tube wall.

- Shrinkage in the Bamboo

When bamboo loses water, it shrinks more than wood and timber. As a result, sufficient precautions must be taken to minimise water loss when bamboo is utilised as a building material.

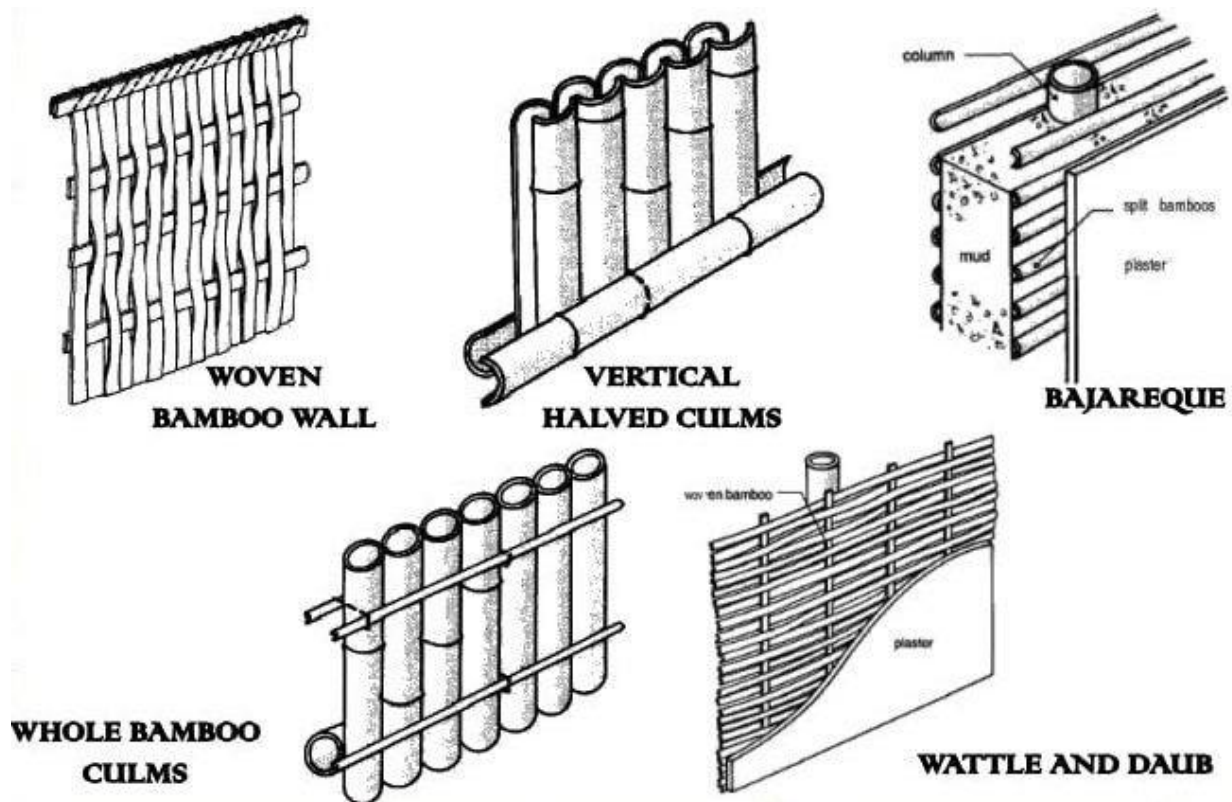
- Fire Resistance

Bamboo has excellent heat retention and insulation properties.

5. Uses of Bamboo in construction[11]

- Bamboo is frequently utilized as a roofing material, providing protection from harsh weather conditions.
- Bamboo is also utilized to make many sorts of partition walls.
- Bamboo is also used to make flooring.
- Because of its excellent load-bearing ability, bamboo is employed as a scaffolding material.
- Because of its high absorbable strength, bamboo is frequently employed as a building material in earthquake-prone locations.
- Bamboo is also utilized in building construction, such as flooring, roofing, and ceiling panels.

- Bamboo may also be utilized as reinforcement in several sorts of structural elements. As a result, it's also known as structural bamboo.



6. Advantages of Bamboo as a construction material

- Because its fibres run axially, bamboo has a higher tensile strength than steel.
- Because bamboo has a high elasticity, it is commonly employed in earthquake-prone areas.
- Bamboo has a great fire resistance and can endure temperatures of up to 4000°C.
- When compared to other types of construction materials, bamboo is less expensive and easier to work with.
- Bamboo is easier to move and construct with.
- Bamboo is a lightweight alternative to other construction materials.
- Bamboo is an ecologically friendly construction material which does not cause environmental pollution.
- Bamboo is a more durable construction resource than other construction materials.

7. Disadvantages of Bamboo as a construction material

- Bamboo shrinks at a much faster rate than other materials.[12]
- If the bamboo isn't cared for properly, it can become infested with fungus or invaded by insects.
- Swelling and shrinking of bamboo in concrete could be a concern.
- During the casting and curing of concrete, bamboo may absorb water.

8. Conclusion

Because of its mechanical capabilities, bamboo can be considered a sustainable alternative to timber and steel, but it is also subject to insect attacks and fungus infection. Because bamboo is abundant in nature, proper steps should be taken to ensure that it is readily accepted and used by modern construction industries. Further research should be conducted to identify ways to reduce the disadvantages that bamboo has as a construction material, and measures should be taken in accordance with those findings to make bamboo a globally accepted sustainable building material in the near future.

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