

# Assessment of Various Aspects in Construction using Bamboo as Building Material

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**Abstract** - Bamboo is a renewable and versatile resource, with high strength and low weight yet it is not used in general practices. Bamboo has a long and well-established tradition as a building material and it is widely used for housing in rural areas. This paper discusses various aspects of construction such as cost, labour requirement and duration of Reinforced Cement Concrete structure v/s Bamboo structure.

**Key Words:** bamboo, duration, cost, labour required, R.C.C. structure, properties.

## 1. INTRODUCTION

The worldwide structures division is developing at high rate, and it will keep on doing as such. Throughout the following 40 years, the world is relied upon to assemble 230 billion square meters in new development. While structures area vitality force has improved lately, this has not been sufficient to counterbalance rising vitality request. Structures related CO<sub>2</sub> outflows have kept on ascending by around 1% every year since 2010, and in excess of 4,000,000 passings every year are mindful to ailment from family unit air contamination. The worldwide structures area expended about 125 EJ in 2016. Structures development, including the assembling of materials for building, for example, steel and concrete, represented an extra 26 EJ (about 6%) in assessed worldwide last vitality use. Representing upstream force age, structures speak to 28% of worldwide vitality related CO<sub>2</sub> outflows. Structures development spoke to another 11% of vitality area CO<sub>2</sub> releases. Be that as it may, a quickly developing structures part, particularly in creating nations, has counterbalanced those enhancements. Somewhere in the range of 2010 and 2016, developing populace, vitality request and ascent of individual per floor territory added to

an extra 57 EJ of total development more than 2010 structures vitality utilization. [2] When looking from a worldwide viewpoint at the worldwide carbon cycle and considering the advantages of bamboo it tends to be said that bamboo can be one of the promising answers for an increasingly reasonable, bio-put together economy based with respect to inexhaustible assets. [1] The bamboo stem with its remarkable properties in this way can be utilized in development moving along without any more preparing.

### 1.1 Current Scenario in India

The development business in India requires enormous measure of labor and material. In India, private structures are the one that are built  $2 \times 10^6$  more noteworthy than other kind of structures like mechanical and business structures every year. The materials utilized in development represents energy utilization of about 61% compared with the complete structure energy. Economic structure improvement appeared, to conquer this issue where the decision of building materials and advancements utilized in development ought to be suitable and ecofriendly. So it ought to fulfill the necessities of the shoppers without making harm the earth and furthermore helps in the personal satisfaction in the structure and society. The expression "Sustainability" is characterized as something that improves the personal satisfaction and thusly makes a solid situation for the individuals to live in. It additionally helps in improving the social and monetary condition for present and group of people yet to come. [5]

## 2 History of Bamboo

Sample paragraph Bamboo is a mammoth grass. It is a significant non-lumber woodland item which has different utilizations for individuals. One of the most conspicuous employments of bamboo is in development. Bamboo has been utilized as a development material from old occasions, particularly by individuals who live in places where bamboo developed normally and liberally. In old occasions bamboo was utilized to manufacture houses due to its normal quality and adaptability. In the cutting edge setting the style of bamboo likewise assumes a significant job. [6]

From numerous years back, bamboo has been utilized as an economical arrangement of building segment of structures in creating nations. It is a quick development material has made this grass a fascinating auxiliary material because of its long sturdiness. Bamboo can even assistance the entire world by its amazing CO<sub>2</sub>sequestrating limit. Bamboo has verifiably been utilized as a structure material because of its intrinsic properties, being recovering with high elasticity and light weight. Minimal effort innovation decreasing the expense of development using locally accessible materials, without giving up the quality, execution and life of the structure. [7]

Bamboo has a long and settled convention as a structure material all through the world's tropical and sub-tropical areas. It is broadly utilized for some types of development, specifically for lodging in provincial zones. Bamboo is an inexhaustible and flexible asset, portrayed by high quality and low weight, and is effortlessly worked utilizing straightforward instruments. [9] India is home to just about 45 percent of the world's bamboo woods and two-third of the developing supply of bamboo in the nation is accessible in the North-Eastern states (Pande et. al. 2008). The yearly exchange bamboo and related items is evaluated at US \$ 15 billion. Having understood this, Government of India has concocted unique spotlight plots on creating applications

with bamboo. The floor space list gauges uncover that bamboo includes about 8.96 million ha of woods territory, which is comparable to 12.8% of the all out timberland front of the nation. India has a sum of 136 animal types. Of which, 125 are indigenous and 11 extraordinary under 75 genera. Out of the absolute bamboo ranch territory, about 28% happen in the North Eastern States. This normal asset assumes a significant job in the work of rustic individuals and in provincial industry. [8]

### 2.1 Species

A sum of around 148 species in 29 genera of bamboos is at present idea to happen in India (both wild and developed). The most extreme grouping of species is found in the deciduous and semi evergreen districts of North-east and the tropical clammy deciduous woods of North and South India. The North-eastern sloping States of India harbor almost 90 types of bamboos, 41 of which are endemic to that district. There are 3 enormous genera (Bambusa, Dendrocalamus, and Ochlandra) of bamboos in India with in excess of 10 species each. Together, these three genera speak to about 45% of the absolute bamboo species found in India. Then again, there are a few genera which are spoken to by just a single animal varieties each for example Ampelocalamus, Sarocalamus, Chimonobambusa, Pseudostachyum, and Stapletonia. Bamboos in India show an incredible decent variety in both their living space and propensity for development. They happen in various backwoods types, running from tropical to sub-elevated zones. A few animal varieties are discovered uniquely in developed state in barely any nurseries. The state-wise appropriation of bamboos in India isn't totally known. Endemism in Indian bamboos is of high request. Over half of the bamboos discovered normally happening in India (71sps) are endemic to the nation. This projection is anyway speculative, since in excess of twelve species have been portrayed as new species from India in the ongoing years and their essence in other topographical locales stays unexplored. None of the wild types of Indian bamboos is known with assurance to have an

undermined protection status. This conclusion might be because of the absence of information on misuse or decrease, and absence of orderly examinations on conveyance and evaluation of danger to these plants, intensified by significant ordered vulnerabilities. In India, the greater parts of the developed bamboos are less helpless, and are now moderated in different Gardens or Bambusetta situated in various pieces of the nation. [10]

## 2.2 Properties of Bamboo

- **Tensile strength:** The strands of the bamboo run hub. In the external zone are profoundly flexible vascular groups that have a high rigidity. The elasticity of these strands is higher than that of steel.
- **Shrinking:** Bamboo recoils more than wood when it loses water. The sticks can destroy at the hubs. Bamboo recoils in the cross segment ca. 10-16 %, in the divider thickness ca. 15-17 %.
- **Imperviousness to fire:** The imperviousness to fire is awesome due to the high substance of silicate corrosive. Topped off with water, it can stand a temperature of 400° C while the water cooks inside
- **Strength Compressive:** The part of lignin influences the compressive quality. Though the high part of cellulose impacts the clasping and the strain quality, since it speaks to the structure substance of the bamboo fiber.
- **Elastic modulus:** regarding the flexible modulus you can see a preferred position in the utilization of thin cylinders corresponding to their cross area, as well. The amassing of exceptionally solid strands in the external pieces of the cylinder divider additionally work positive regarding the flexible modulus as it accomplishes for the pressure shear and twisting quality. There exist an ideal connection of the cross segment of the cylinder, in the event that you fall beneath or above it the flexible modulus diminishes (the higher the flexible modulus of the bamboo, the higher is the quality). Like the flexible modulus of strong wood the one of bamboo likewise diminishes 5 to 10% with developing pressure. The

colossal versatility makes bamboo to be an exceptionally helpful structure material in territories with high danger of quakes. In Asia they despite everything develop frameworks with bamboo tubes

- **Flexural (bowing) strength:** A tropics examined regular bamboos: distance across of tubes= 70-100 mm, divider thickness= 6-12 mm with a range of 3,60m. The flexibly avoidances were least =1/25 under most extreme 1/16, and as a normal 1/20,1 of the ranges. Where a diversion in the development was unavoidable and irritating, one could twist the as of late gathered cylinders with the goal that you get a super height, which later will be remunerated under the working burden.
- **Shearing strength:** Especially for the development of the bamboo tube going along with it is critical to think about the shearing opposition. The impact of the separation of the shearing surface declines with developing length of shearing surface. At a divider thickness of 10 mm the shearing quality is about 11% lower than at a cylinder with a divider thickness of 6 mm; this could be clarified by the dispersion of the high-quality strands per cross segment surface. [11]

## 2.3 Jointing techniques

Successful jointing is basic to the basic trustworthiness of a confined development. Moreover, the appropriateness of a material for use in surrounding is to a great extent subordinate upon the straightforwardness with which joints can be framed. Due to its round, cylindrical structure, jointing of at least two bamboo individuals requires an alternate way to deal with that embraced for, state, strong wood. Notwithstanding its moderately high quality, bamboo is vulnerable to squashing, especially of open finishes. It is likewise portrayed by an inclination to part; the utilization of nails, pegs, scores or mortises can in this manner bring about significant decreases in quality. Associations should likewise adapt to varieties in width, divider thickness and straightness.

Unmistakably, these constraints have not introduced an obstruction to the utilization of bamboo in customary types of development. Be that as it may, the structure of fundamentally proficient, increasingly tough and conceivably bigger and progressively practical bamboo structures will depend to a huge degree on upgrades and advancements in jointing innovation. The essential joint sorts are:

- Spliced joints
- Orthogonal joints
- Angled joints
- Through joints
- Spliced joints: (at least two) culms are participated in line to frame longer individuals.
- Orthogonal joints: These are the commonest kinds of joint, where at least two individuals meet or cross at right edges. The fundamental arrangements are: Butt joint and Crossover joint.
- Angled joints: These are shaped where at least two individuals meet or cross other than at right edges. For butt joints, the closures of the part can be molded to fit similarly as a symmetrical seat joint. Horns (essential joints) may likewise be utilized yet manufacture is tedious. Models would incorporate web individuals in supports. Calculated hybrids can be managed similarly as symmetrical hybrids, for instance the inclining supporting in the plane of a rooftop.
- Through joints: Members of contrasting distances across can be joined by going the littler through an opening penetrated in the bigger. The joint is made sure about by a dowel going through the two individuals. Applications for this kind of joint may incorporate segments, entryways and window surrounding. [3]

### 3. Assessment of various Aspects of R.C.C Building.

There are various structural components in a building such as footings, columns, beams, walls, slab, flooring, etc. Building also has various elements such as plastering, painting, window fixing, door fitting, plumbing,

electrification, etc. Out of all these this paper focuses on structural components such as footings, columns, walls and slab. Various aspects related to the construction project are machine, manpower, money, time consumption, etc. This paper discusses the cost of construction including material cost and labour cost, labour requirement, and time consumed to build a small 1 Room Kitchen (1RK) of about 250 sq.ft. including a W.C. and bath.

#### 3.1 Time consumption

Time consumption includes time required to construct particular structural element such as footing, column, walls, beams, slab including from shuttering to casting. Casting is done on site so as to consider the various problems occurring on site. Time consumption depend mainly on the construction speed, but the time required to set the concrete cannot be avoided. Minimum time for deshuttering for slab, concrete setting time, are the various barriers which also affects the overall time consumption of any project. Further time is required for curing too which is not required in bamboo building.

##### 3.1.1 Time consumption for Footing.

Number for footing required for a small RK of 250 sq. ft. is considered to be six. Time required for footing excluding excavation and including shuttering, placing steel, and casting on site is about 10 days ( 3 days for footing and 7 days curing time).

##### 3.1.2 Time consumption for Columns.

Depending on the number of columns i.e. 6 and height required i.e. 8 feet time required for shuttering, fixing steel, casting of column and curing time the total time consumed is about 9 days (2 days for columns and 7 days curing).

##### 3.1.3 Time consumption for beams and slab.

Time required for beam and slab is taken together as it is casted on site at the same time. Time consumed to cast a 250 sq. ft. slab along with shuttering, steel fixing, casting, curing and deshuttering is about 24 days (3 days for slab casting and remaining 21 days minimum for curing and deshuttering).

### 3.1.4 Time consumption for walls.

Tine required for constructing walls up to slab height including brickwork and plastering is about 30 days.

### 3.2 Labour requirement

Labour requirement includes labours whether it may be men or women. Again various aspects of labours such as working capacity, skill, etc. affects the number of labour required to do a particular work. Sometimes a skilled labour does more job than an unskilled but experienced labour.

#### 3.2.1 Labour required for footing.

The number of labours required for footing for shuttering, steel cutting and placing, and casting six footings is six.

#### 3.2.2 Labour required for columns.

Number of labours required for shuttering, placing steel and casting of six columns is four.

#### 3.2.3 Labour required for beams and slab.

Number of labours required for casting slab and beams including shuttering, placing steel, casting on site and deshuttering is 10

#### 3.2.4 Labour required for walls.

Number of labour required for brickwork and plastering is not accurate as it is a big and slow process of about one month. Therefore considering daily two labours for brickwork and two labours for plastering almost forty labours are required.

### 3.3 Cost of material and labour

Cost includes the material and labour cost i.e. cost of material required to complete the work and salary of the labour for their working days. Average material cost is considered according to the market. This cost may go up and down according to the available stock or recession. Labour cost may also hike due to some or the other reason.

#### 3.3.1 Cost of footing.

Cost of footing including material and labour cost for shuttering, steel and casting is 8000/- per footing. We have six footing in total so the cost of footing goes about 48000/- Indian rupees.

#### 3.3.2 Cost of columns.

Cost of columns include cost required for materials and labour for shuttering, steel and casting is 2500/- per column. We have six columns so the total cost of column is 2500\*6 which is 15000/- Indian rupees.

#### 3.3.3 Cost of beam and slab

Cost of beam and slab including material and labour cost for shuttering, steel and casting for 250 sq. ft. area is around 70000/- Indian rupees.

#### 3.3.4 Cost of walls.

Cost of walls of including material and labour cost for brickwork and plastering is 170000/- Indian rupees.

### 4. Assessment of various Aspects of Bamboo Building.

Similar to aspects of R.C.C. building Bamboo building also have same aspects, only difference is between the material. This paper considers same design for bamboo building which is similar to R.C.C. building i.e. 1RK of 250 sq. ft. using bamboo as building material. Similar study was carried out on bamboo building as R.C.C. building and following conclusion is drawn.

### 5. Comparative study.

A comparative study is made after obtaining the required data regarding the various aspects such as time, labour requirement and cost of construction and presented in the tabular form as shown below.

Aspect	Component	R.C.C. Building	Bamboo Building
Time ( in days)	Footing	10	8
	Column	9	2
	Beam And Slab	21	30
	Wall	30	8
Labour requirement (in number)	Footing	6	5
	Column	4	2
	Beam And Slab	10	4

	Wall	40	10
Cost of material and labour (Indian Rupees)	Footing	48000/-	30000/-
	Column	15000/-	8000/-
	Beam And Slab	70000/-	50000/-
	Wall	170000/-	58000/-

The overall construction cost for R.C.C. building goes up to Rs. **1350** to Rs, **1500**/- per square feet.

The overall construction cost for Bamboo building goes up to Rs. **600**/- to Rs. **1200**/- per square feet and more depending on the quality of the construction required.

## 6. CONCLUSION.

Bamboo has different species and it have various uses according to its species depending on what the bamboo is used for. It also has good properties suitable for construction such as tensile, shrinking factor, compression, fire resistance, elastic modulus, etc. Jointing techniques are also explained in this paper and using these jointing techniques bamboo can be used in construction. Sooner bamboo will be no long 'poor man's timber' and it will be used all over the world for construction purpose. Bamboo building as compared to R.C.C. building costs less and hence, bamboo can be used on a large scale specially in areas where there is a natural disaster which has caused a huge damage to the surroundings. Due to its fast and speedy construction bamboo building can be constructed after the disaster such as flood and earthquake. Time, labor and cost required for R.C.C. building are much less as compared to Bamboo building. Further, much research is needed to be done on bamboo and its various uses in construction so as to make awareness in the society.

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