International Conference on Emerging Trends in Engineering, Technology, Science and Management
IIMT College of Engineering, Greater Noida, India (ICETETSM-17)
12th April 2017, www.conferenceworld.in ISBN: 978-93-86171-38-2

BAMBOO: THE NEW ERA STEEL

Md.Atif Hussain, Adil M Ansari, Md.Saif Raza

IIMT College of Engineering, Greater Noida, India

ABSTRACT

With the modern speed of urbanization, construction is the most important and busy industry. Population is increasing, technology is being improvised, mass population is migrating to urban areas, and the list goes on-need of construction. Recently, in the attention in response to global warming issues and sustainable society, the manufacturing using natural materials has become actively. Bamboo, low cost, fast growing, and broad distribution of growth, is expected to contribute significantly to earthquake-resistant construction and seismic retrofit technology in the developing countries. The behavior of bamboo as a reinforcement material, its growth properties, physical strength, scope of it to be used on a large scale, economic and environmental benefits are to be discussed henceforth.

I. INTRODUCTION

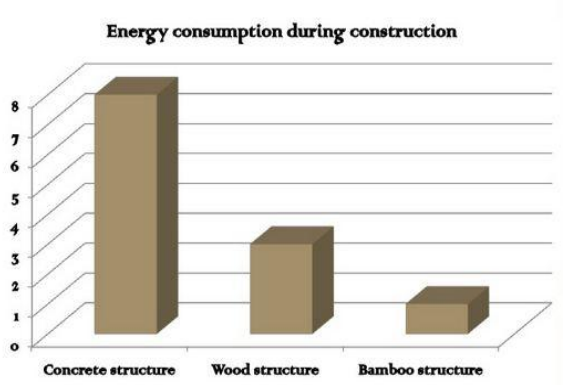
In recent years, steel prices have soared. For developing countries, steel is difficult to obtain because of expensive prices, and for the construction industry, usage of steel is currently limited heavily. The production of steel has high consumption of fossil fuels, so, the steel discharge in the construction of structures has been presented, showing the possibility of drastic reduction by research institutes. Meanwhile, for developing countries, it is important to make the development of buildings construction; low cost, no requirement of sophisticated technologies and reliable construction methods. Environmental destruction such as pollution of air and water has been occurring in some regions by rapid development and production of materials like iron, steel, glass, cement that use limited mineral resources. On the other hand, plants and fibers are annually reproducible clean resources. Bamboo is a unique group of gigantic grasses the culms of which originates in underground rhizomes. It grows naturally in many parts around the world country but some species are artificially planted. Bamboo forests are found across tropic and sub-tropic zones between latitudes of about 40° south, i.e. areas with mean annual temperatures of from 20° C to 30° C. Bamboo suitable for water pipes grows at altitudes from 20 to 3,000meters. The plant is fully mature at an age of three to four years.

II. SCOPE

"MAX OUTPUT + MIN INVESTMENT = SUSTAINABLE DEVELOPMENT"

CARRYING OUT STRENGTH, DURABILITY WHILE SIMULTANEOUSLY KEEPING THE PROJECT ECONOMICAL, HAS BEEN A MAJOR PROBLEM FOR THE CIVIL ENGINEERS. AS SUCH, BAMBOO EMERGES OUT TO BE THE APPROPRIATE ALTERNATIVE. OVERPOWERING NORMAL REINFORCEMENT ON THE SCALES OF STRENGTH, DURABILITY, RESISTANCE TO BUCKLING AND BEING MUCH MORE ECONOMICAL, BAMBOO WILL SERVE AS THE BEST ALTERNATIVE FOR WHAT WE HAVE IN USE NOW. THUS, WITH THIS PROJECT WE WOULD LIKE TO PUT IN

TOGETHER THE POSITIVENESS OF USING THIS GIFT OF NATURE IN THE CONSTRUCTION FIELD AND THE REASON WHY THIS THECNIQUE NEEDS TO BE TAKEN INTO PRACTICE.



III. NEED

AROUND 2 BILLION PEOPLE WILL IMMIGRATE TO THE CITIES IN 30 YEAR. THAT WOULD REQUIRE A LARGESCALE CONSTRUCTION. THAT WOULD ULTIMATELY LARGE SCALE CARON EMISSION. BAMBOO ON THE OTHER HAND SUPRESSES CARBON FROM ATMOSPHERE AND THECARBON EMITTED DURING THE PRODUCTION OF CONSTRUCTION MATERIALS IS ALSO REDUCED TO A LARGE SCALE.

IV. SELECTION AND PREPARATION OF BAMBOO

Selection

The following factors should be considered in the selection of bamboo culms (whole plants) for use as reinforcement in concrete structures:

1. Use only bamboo showing a pronounced brown color. This will insure that the plant is at least three years old.
2. Select the longest large diameter culms available.
3. Do not use whole culms of green, unseasoned bamboo.
4. Avoid bamboo cut in spring or early summer. These culms are generally weaker due to increased fiber moisture content.

Preparation

SIZING

Splints (split culms) are generally more desirable than whole culms as reinforcement. Larger culms should be split into splints approximately 3/4 inch wide. Whole culms less than 3/4 inch in diameter can be used without splitting. (See Fig 4)

Splitting the bamboo can he done by separating the base with a sharp knife and then pulling a dulled blade through the culms. The dull blade will force the stem to split open; this is more desirable than cutting the bamboo since splitting will result in continuous fibers and a nearly straight section. Table II shows the approximate net area provided by whole culms and by 3/4-inch-wide splints, as well as the cross-sectional properties of standard deformed steel bars and wire mesh.

SEASONING

When possible, the bamboo should be cut and allowed to dry and season for three to four weeks before using. The culms must be supported at regular spacing to reduce warping.

BENDING

Bamboo can be permanently bent if heat, either dry or wet, is applied while applying pressure. This procedure can be used for forming splints into C-shaped stirrups and for putting hooks on reinforcement for additional anchorage.

WATERPROOF COATING

When seasoned bamboo, either split or whole, is used as reinforcement, it should receive a waterproof coating to reduce swelling when in contact with concrete. Without some type of coating, bamboo will swell before the concrete has developed sufficient strength to prevent cracking and the member may be damaged, especially if more than 4 percent bamboo is used. The type of coating will depend on the materials available. A brush coat or dip coat of asphalt emulsion is preferable. Native latex, coal tar, paint, dilute varnish, and water-glass (sodium silicate) are other suitable coatings. In any case, only a thin coating should be applied; a thick coating will lubricate the surface and weaken the bond with the concrete.

V. TYPES OF BAMBOO

- BAMBUSA BALCOA (COMMON NAME: FEMALE BAMBOO)
- TROPICAL CLUMBING BAMBOO ORIGINATING FROM NORTH-EAST INDIA
- DIAMETER: 6-15 cm INTERNODES: 20-40 cm LONG
- STRENGTH : 39.4-50-6 N/mm2 * GREEN CONDITION(G.C)
  51-57.3 N/mm2 * DRY CONDITION(D.C)
- MODULUS OF RUPTURE : 85-62.4 N/mm2 (G.C)
  : 92.6-69.6 N/mm2 (D.C)
- MODULUS OF ELASTICITY : 7.2-10.3KN/mm2 (G.C)
  : 9.3-12.7 KN/mm2 (D.C)

- BAMBUSA BAMBOS (COMMON NAME: INDIAN THORNY BAMBOO)
- TROPICAL DENSECLUMPING BAMBOO NATIVE TO SOUTH-EASTASIA.
- FIT FOR CONSTRUCTION PROCESS.
- HEIGHT: 20-3m DIA: 10-18cm
- STRENGTH
  - * FIBER STRESS - 18.3-26.5 N/mm2
  - *MODULUS OF RUPTURE - 35-39.3 N/mm2
  - * MODULUS OF ELASTICITY - 1.5-4.4 KN/mm2
  - * MAX CRUSHING STRESS - 31.1-47 N/mm2
- 15% TOTAL AVAILABLE IN INDIA
- DENDROCALAMUS GIGANTEUS
- (COMMON NAME: GIANT BAMBOO)
- CULMS DIA: 18-25 cm
- ONE OF THE LARGEST BAMBOO SPECIES FOUND MAILY IN TROPICAL ASIA.
- HEIGHT: AROUND 30m
- IDEAL FOR ROOM DECORATION, WALLS, CEILING S, FLOORS, etc.
- DENDROCALAMUS STRICTUS
- CULMS DIA - 2.5-8 cm
- HEIGHT : 8-20m
- TROPICAL – SUBTROPICAL CLIMATE
- ORIGIN OF SOUTH EAST ASIA
- USED IN LIGHT CONSTRUCTION, FURNITURE AND MUSICAL INSTRUMENTS.

VI. BEAMS AND GIRDERS

Flexural members reinforced with bamboo can be designed quite efficiently. Bamboo longitudinal reinforcement should be between 3 and 4 percent of the concrete cross section.

The curve provides the cross-sectional dimensions of a bamboo reinforced beam that will have the same bending moment resistance coefficient as a balanced steel reinforced beam, singly reinforced. Economy of concrete increases going to the left on the curve; therefore, deeper, narrower replacement beams are recommended.The number and size of bamboo reinforcing rods (culms or splints) can be selected accordingly. These curves are drawn for 3 percent of the concrete cross section as bamboo reinforcement which is in the

optimum range for flexural members. Other reinforcement percentages can be used as noted on the figure. A minimum number of rods should be used to provide adequate spacing. The bamboo stirrup area should always be about 4 times the steel stirrup area.

VII. COLUMNS

Bamboo reinforcement in columns serves to resist a compression load equal to that taken by the concrete it displaces; it also will resist shear and tensile stresses. Of the full cross section of concrete, only 80 percent is considered effective in rectangular tied, columns. Allowable concrete stress should not exceed 0.225 f'_c where f'_c is the ultimate compressive strength of the concrete.

Vertical reinforcement should be approximately 4 percent of the column cross section for rectangular columns. When bamboo is used as lateral tie reinforcement, the ties should be spaced not over 16 times the least dimension of the vertical reinforcement nor farther apart than the least dimension of the column. Enough ties should be provided so that every vertical bar is held firmly in its designed position and has lateral support equivalent to that provided by a 90-degree corner of a tie. A common rule for determining the size of a tie is that its cross-sectional area is 2 percent of the area of all the vertical reinforcement confined by it.

The concrete cross-sectional area of bamboo reinforced rectangular columns conservatively should be 2.25 times the concrete area of steel reinforced rectangular columns, indicating a 50-percent increase in face dimensions.

VIII. GROUND SUPPORTED SLABS

In general, the reinforcement spacing should not be greater than the slab thickness. When designs are available for steel reinforced slabs, no change in thickness is required when reinforced with bamboo instead of steel. However, the volume of the bamboo matting reinforcement should be about 4 times the amount used for steel matting.

IX.WALLS

Non-bearing concrete walls should have a thickness of not less than 5 inches and not less than 1/30 the distance between the supporting or enclosing members; they should be reinforced with at least 3/4-inch-diameter culms on 6-inch centers in both vertical and horizontal directions. This reinforcement should be provided as a one-layer mat in the middle of the wall. Two bamboo culms 1/2 inch or more in diameter should be placed above and at the sides of openings, and two 3/4-inch-diameter culms 4 feet long should be placed diagonally across the corners of opening

X. DURABILITY OF BAMBOO MATERIAL

Its property of being a natural product make it more exposed to environmental agents and insects. A remedy against this is to undergo bamboo curing.

The curing process enables the treatment of humidity content and the starch within it, which is the main reason for insect attraction. The curing is effective only if the chosen bamboo is right one. As mentioned in the selection of bamboo.

The curing of bamboo can be done either by:

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1. Curing on spot
2. Immersion process
3. By heating
4. Smoke Curing

The treatment must be done when the bamboo is in a dry state so that the penetration undergoes in the right way. The preservation treatment done on bamboo to take care of durability factor should have no effect on the chemical composition. The treatment itself should last, without being washed away under high water conditions if any.

Durability is a major concern for bamboo material. The physical and chemical properties of bamboo are found high with low content of humidity within it. This low content would keep away molds in bamboos.

[fig.2 Bamboo Reinforced after 15 yrs exposed to open air]

[fig.1A column steel reinforcement bars after 10 years exposed within a closer area]

XI. BAMBOO FOR FOUNDATIONS

There is very limited use of bamboo as foundation material because when in contact with moisture laden surface they decay fast. However, this issue can be tackled to quite an extent though proper treatment using appropriate chemicals.

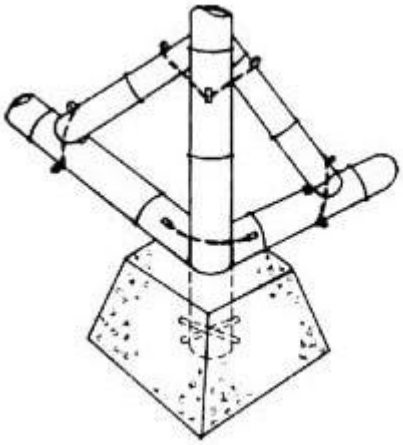
The various types of foundations constructed with bamboo are:

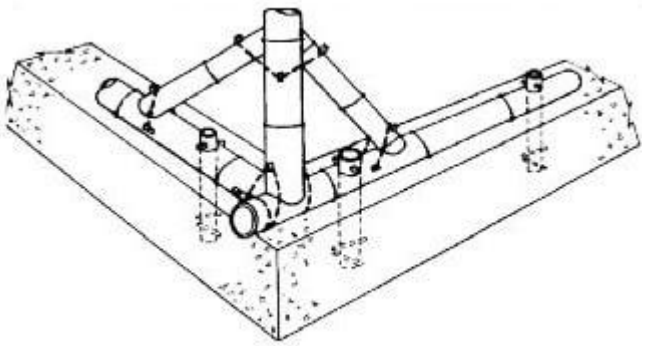
a) Bamboo which is in direct contact with ground surface.

b) Bamboo fixed to rock or preformed concrete footings

c) Composite bamboo or concrete columns

d) Bamboo piles



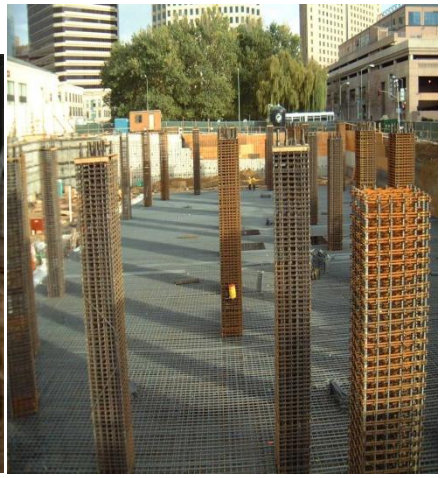


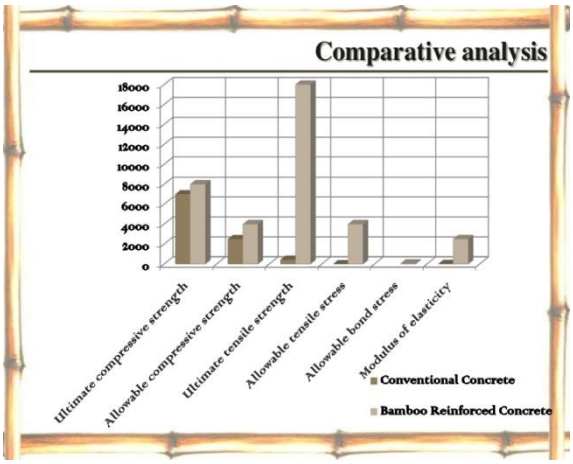
Advantages of Bamboo as a Building Material

The various advantages of bamboo are as mentioned below:

1. **Tensile strength**: Bamboo has higher tensile strength than steel because its fibers run axially.
2. **Fire Resistance**: Capability of bamboo to resist fire is very high and it can withstand temperature up to 4000 C. This is due to the presence of high value of silicate acid and water.
3. **Elasticity**: Bamboo is widely preferred in earthquake prone regions due to its elastic features.
4. **Weight of bamboo**: Bamboos due to their low weight are easily displaced or installed making it very easier for transportation and construction.
5. Unlike other building materials like cement and asbestos, bamboo poses no danger to health.
6. They are cost effective and easy to use.
7. They are especially in great demand in earthquake prone areas.

XII. CURRENT STATUS [GALLERY]





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