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Study on bamboo reinforcement concrete structure

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ABSTRACT

Bamboo is used as a construction material from earlier days of construction. It was used as reinforcement in a rural area and as formwork also. Concrete is a brittle material so it cannot be used as a single material in construction due to its low tensile strength. In this study, we tried to find out the properties of bamboos from the past studies and from the past study we can find out the better way to improve strengths of bamboo as a reinforcement in concrete structures.

Keywords— *Bamboo, Concrete, Reinforcement*

1. INTRODUCTION

Bamboo is a likely complex material with a high strength-to-weight ratio helpful for structures. Bamboo as a construction material is conventionally connected with the cultures of South Asia, East Asia, and the South Pacific, to some extent in Central and South America. In China and India, bamboo was used to hold up simple postponement bridges, either by making cables of split bamboo or twisting entire culms of adequately pliable bamboo as one. Bamboo has also long been used as scaffolding; the practice has been banned in China for buildings over six stories but is still in continuous use for skyscrapers in Hong Kong. In the Philippines, the Nipa Hut is a fairly typical example of the most fundamental sort of housing where bamboo is used; the walls are split and woven bamboo and bamboo slats and poles may be used as its support. In architecture, bamboo is used primarily as a supplemental and/or decorative component in buildings such as fencing, fountains, grates, and gutters, mostly due to the ready abundance of quality timber. A variety of structural shapes may be complete by training the bamboo to imagine them as it grows. Bamboo as a construction material is conventionally connected with the cultures of South Asia, East Asia, and the South Pacific, to some extent in Central and South America. In China and India, bamboo was used to hold up simple postponement bridges, either by making cables of split bamboo or twisting entire culms of adequately pliable bamboo as one. Bamboo has also long been used as scaffolding; the practice has been banned in China for buildings over six stories but is still in continuous use for skyscrapers in Hong Kong. In the Philippines, the Nipa Hut is a fairly typical example of the most fundamental sort of housing where bamboo is used; the walls are split and woven bamboo and bamboo slats and poles may be used as its support. In architecture, bamboo is used primarily as a supplemental and/or decorative component in buildings such as fencing, fountains, grates, and gutters, mostly due to the ready abundance of quality timber. A variety of structural shapes may be complete by training the bamboo to imagine them as it grows. Squared sections of bam are created by compressing the growing stalk within a square form. Arches may similarly be created by forcing the bamboo's growth into the desired form, costing much less than it would obtain the same shape with regular wood timber.

(a) The durability of Bamboo as concrete reinforcement: The durability varies with the type of species, age, conservation condition treatment and curing. There is a strong relationship between insects attack and the levels of starch plus humidity content of bamboo culm. There is only a slight deterioration in the mechanical properties as compared to initially treated bamboo after 10 years [Lima et al. 2008] when a bamboo reinforced beam after tested is exposed to open air. Working as reinforcement in concrete, bamboo splints usually have large dimensions. This fact means that the great majority of bamboo fibres completely encased in the parenchyma and they are not directly exposed to the alkalinity of the cementious matrix, therefore the higher number of the fibre endpoints is not detrimental.

(b) Mechanical properties of bamboo and its behaviour as reinforcement in concrete: The tensile stress of bamboo can reach up to 370 N/mm2. The elastic modulus of bamboo as reinforcement is found as high as 51428.6 MPa and the yield strength of 109 MPa. The ratio of tensile strength to the specific weight of bamboo is six times greater than that of steel. The strength distribution at the bottom of the bamboo culm is more uniform than at l1m the top. The strength of bamboo also increases with age and maximize after 3-4 years. In the nodes, the average fracture toughness is lower than the minimum value of the entire culm. In establishing the mechanical properties of bamboo, in the elastic range, the rule of the mix for the composite material is used. The properties of the fibres and matrix with their volumetric fractions are taken into account. It is concluded that vascular bundle size (radial/tangential ratio) and fibre length correlated positively with a modulus of elasticity and stress at proportional limits. The correlation between fibre length and shear strength was negative.

(c) To check the feasibility and reliability of using bamboo splints as reinforcing the material in concrete elements & to

select and prepare the most appropriate kind of bamboo specimen to be used in a concrete element as reinforcement. The following tests were performed to date on different bamboo specimens:

(1) Density test.
(2) Initial moisture content test.
(3) Water absorption test.
(4) Compression test.
(5) Tension test.
(6) Bond Test

2. LITERATURE REVIEW

Brink and Rush (1966) proposed the design procedure and chart for concrete construction and conversion method from steel reinforced concrete design with the modified characteristics of bamboo reinforcement to estimate the ultimate load carrying capacity of the precast concrete elements with bamboo reinforcing. It also showed that of a full cross-section of concrete only 80% is considered effective in rectangular tied.

Rahman et al (2000) studied the stress-strain diagram with a number of the node as a variable parameter from which he found that it possesses a low modulus of elasticity. The study proposed that bamboo reinforced concrete beams with steel stirrups will improve its load carrying behaviour.

Iyer (2002) bamboo to be worthy and cost-effective material to be used as reinforcing in bearing masonry for seismically safe houses. The study makes the comparison of bond strength in the presence and absence of node in mortar block. It concluded that for better shear resistance larger area of the bamboo splint is preferred and for better bonding lesser splint area is advisable.

Ghavami (2005) shows that microstructure of bamboo as a functionally gradient material has been a most important parameter in determining structural properties (flexural as well as axial). He also studied the thickness vs. internode number and Young's modulus vs density feature. Khare (2005) studied that the fracture points of the tensile samples containing nodes occurred at the node which was verified experimentally. The study showed that the specimens with nodes behaved in a less ductile manner with higher strength than those without nodes.

Lima et al (2008) presented the results of an experimental investigation made to evaluate bamboo durability to be used as concrete reinforcement. This specific study concerns the durability of bamboo exposed to tap water and calcium alkaline solutions. Bamboo splints were exposed to cycles of wetting-drying and possible decay in tensile strength and Young‟s Modulus was investigated. The experimental tests in this study showed that the strength is comparable to steel. The „stress vs strain‟ curve as found to be linear up to the failure.

3. DISCUSSIONS

Bamboo has excellent properties as a potential reinforcement for low-cost housing. Better ductility behaviour and local availability favour its mass use. It cannot be used directly after cutting down without using suitable treatment to prevent it from yeast, bacteria etc. which is a very tedious and laborious process and sometimes it is required to make it suitable for use as reinforcement. The strength parameter cannot be generalized for different types of bamboo as a strength for different species is different. The water-absorbable capacity cause voids on drying due to shrinkage (swelling and shrinking of bamboo). But as bamboo is weak in shear it cannot be used as shear reinforcement in R.C.C structure. Bamboo is weak at node section major failure in bamboo occurs at the node. Since the variation may be quite significant in some cases the factor of safety to be assumed in the design process should be high as compared to a conventionally used factor of safety to accommodate the variation in strength and ensure the safety of the structure constructed.

4. CONCLUSION

It is the versatility that helped bamboo meander its way through Oriental cultures, becoming an integral part of the rich and the poor alike; a bare necessity as well as a commodity of pleasure. The ecological impact of bamboo would be hard to set aside. Bamboo, as with any natural material, has a very high degree of variation depending upon location, soil conditions, climate, species, a maturity of the plant, the season of harvesting etc. Based on the several experimental investigations in the past it can be said that bamboo can efficiently replace the steel as reinforcement for low-cost residential structure. The numerical data of several engineering parameters supports it. Based on the literature available, it was found that the research work in using bamboo as reinforcement in concrete is vast. However for smaller applications such as household articles, bamboo reinforcement using lightweight c concrete the number of publications available is scarce. Bamboo reinforced concrete can be made for benches, tables and stools in schools, parks, hotels, railway stations etc. to make the eco-friendly environment and for low-cost construction. The positive aspects of bamboo such as lightweight design, better flexibility and toughness due to its thin walls with discretely distributed nodes and its great strength make it a better building material.

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