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BAMBOO AS A REINFORCEMENT MATERIALS

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A B S T R A C T

Concrete is a principal building material used all over the globe. Concrete's tensile strength is weak while its compressive strength is high. This necessitates the use of steel as a reinforcement material to make it strong in tension. –Steel is costly and easily corroded thereby leading to structure decay. Because of this, concrete can be replaced with bamboo because of their properties such as light weight, high strength, durable and easily renewable.- So that Bamboo replaces steel which was commonly used in construction industries for reinforcement purposes by traditional methods-The truth is that bamboo is an indigenous, affordable and plentiful resource.—Also It has necessary deflection and tensile strength—Bamboo reinforcement reduces the mid span deflections-Lastly performance of bamboo will be compared with that of steel so as to get the best result.

Keywords: *Concrete reinforcement, Bamboo as reinforcement, Steel vs bamboo in construction.*

IJAMSR

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1. INTRODUCTION

Behold the giants of the grass clan— bamboo. Unlike most plants, these hollow-stemmed wonders feature scattered vascular bundles instead of neatly arranged cylinders within their intermodal regions. Let me tell you about speed: bamboos are some of the fastest growers on this planet. Imagine a plant reaching 91cm in just one day— that's bamboo for you. But they're not just fast; they're also important economically and culturally. Used for construction and various other purposes, bamboos boast a higher compressive strength than brick, wood or even concrete, along with a specific tensile strength greater than that of concrete. The global timber demand is on the rise but unfortunately the supply is dwindling. Bamboo, when treated industrially, has shown superior strength abilities— a material that could be used in cost-effective composite components for both structural and non-structural applications in construction. Most developing countries have high demands for steel-reinforced concrete yet they lack the capacity to produce steel locally, which leads to an unmet need despite high demands placed upon them. Bamboo, as an abundant and sustainable resource, exhibits high resilience and can potentially replace steel in areas where production is challenging. It achieves strength through its hollow structure that evolved to withstand wind forces: lightweight design makes harvesting easy due to transport considerations (based on location); rapid growth cycle alongside wide geographical adaptability make bamboo low-cost while also acting as a grass for CO2 absorption purposes. Investment in developing bamboo as reinforcement can alone provide incentive for the factors. Scientific and technological progress demands new approaches towards bamboo processing: durability is vital, as is suitability as a building material. Investigations have been undertaken on both the basic characteristics of bamboo itself and the methods by which it can be transformed into different composite materials. Bamboo boasts a number of distinctive qualities— it grows rapidly with high yield, reaching maturity in short time periods. Moreover, it grows abundantly at low cost, making it an economically viable option.

2. LITERATURE REVIEW

Kumar and Vasuki's (2014) experimental study investigated the effects of bamboo on the flexural strength of concrete beams. Their study assessed beams reinforced with bamboo versus steel, and the effect of bamboo as a non-corrosive and sustainable reinforcement in concrete members. The treated bamboo reinforced beams (with epoxy coating and fine sand) were tested alongside bamboo stirrups for use in reinforcement of concrete beams. This was compared to conventional steel stirrups. They also studied the durability, strength, and environmental benefits of bamboo when it replaces steel in bins of reinforced concrete. The intention was to determine if bamboo can replace steel in a reinforced concrete beam for increasing the life of the beam, strength, and sustainability.

The researchers conducted an experimental analysis on the bending strength of laminated bamboo beams (James et al., 2014). Yushaniya alphina is a type of species in bamboo. The adhesive used to laminate the bamboo strips was a strong type of Polyvinyl Acetate Adhesive. The process of cutting and splitting the bamboo involves using the press-and-split machine. Before boiling and drying, the outer part of it which is smooth and soft must be removed. Then, it should be immersed in hydrogen peroxide solution for three hours and treated with preservative agent boric acid and borax oxide that can control termites as well as fungi. Secondly, water from bamboos evaporates leaving salts which settles on them for three months when

IJAMSR

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12% moisture content is achieved after air drying. A comparison was made between six beams made of laminated bamboo and three similar ones made of cypress timber. The load carrying capacity of a beam made from bamboo laminate is higher than that constructed from cypress.

A Review by Farhana Naznin et.al (2015). Bambusa tulda was splitted into splints measuring 16mm then Cu-Cr-Boron treated followed by surface drying; this same procedure was done for 20mm splints as well. Two types are plain or torched-zigzagged splints. The only tor splints are coated with bitumen and sprinkled with sand to increase the bond strength of them. Steel is used as a stirrup material for boxing bamboo reinforced concrete which is finally casted. The right proportion of concrete mix and water cement ratio is adopted. Flexure, tension and moisture content of bamboo splints are also tested for at this point in time. To attain better flexural performances on bamboo reinforced beams, more number of reinforcements, diameter of bar and shear links were designed based on results obtained. This reduced mid span deflection as well increased flexural strength.

Bamboo reinforced cement concrete has been studied by Jigar K. Sevalia et.al (2013). To evaluate the behavior of bamboo, tensile test on bamboo stirrups, compression test on cement concrete cubes and flexural test on bamboo reinforced concrete beams were carried out. For tensile testing a length of 520mm along with thickness 10mm was used for both ends which were roughened to get good grip over it. In order to conduct compression tests, cement concrete specimens measuring 150mm x 150mmx 150mm were prepared and cured before testing. Three different types of flexural beams were prepared for the flexural test: plain cement concrete beams without bamboo stirrups, singly reinforced cement concrete beams with two untreated bamboo stirrups at the bottom, double reinforced concrete beams with two untreated bamboo stirrups both at the top and bottom of the beam. Brittle failure is manifested by the abrupt failure of a simply-supported concrete beam without any prior warning signifying the failure immediately after reaching the maximum breaking strength when the load is applied to the material evidently inside its elastic range that Ogunbiyi et al in 2015, compared the strength and spiramidal reinforcement of bamboo and steel bars for building construction.A high-yield 10mm, 12mm, 16mm, 20mm, and 25mm diameter mild steel bars are made Bamboo culms having a diameter 10mm, 12mm, 16mm, 20mm and 25mm were produced Tensile tests for all these three samples in different diameters were conducted is larger in the doubly reinforced beam rather than the singly reinforced.

Machakos Luo (Njarakaran-Yallah, 2010) researched on the influence of language proficiency levels on reading comprehension among form one students in Luo Language Luo directional inflectional markers include We have observed that bamboo has low capacity for tension and thus brittle in failure when loads are applied because of inadequacy of breaking force. It is suitable for partition walls, roofing and other forms of light construction, but should not be used in heavy engineering projects. In the performance evaluation of bamboo with mortar and concrete.

HMA Mahzuz and others (2011) presented findings. There were different types of samples that included a sample of bamboo alone, a composite sample of bamboo where it was filled with mortar in the cavity, a combination with sand, cement, and stone chips in the hole filled in it, as well as another sample of bamboo reinforced column that had bamboos sticks instead of steel bars.To prepare the first sample, only air-dried and worm-free bamboos measuring one-foot long were used. Hollow internodal regions were created in the

IJAMSR

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bamboo and the ends were cut perpendicular to the surface. For the second sample, a bamboo measuring one-foot long was used for testing. Concrete is used to fill up the hollow part of the sample. By the 16th day of curing, the sample was allowed to dry in the open air to avoid swelling and foul smell. The curing process is prolonged and another sample is dried in open air again within two days. It is necessary that a bamboo sample measuring one foot be chosen for every 1ft selected in order to prepare sample number three. With sand, stone chips as well as cement filling empty spaces in bamboo samples that have hollow sections. The fourth type of sample was prepared by creating bamboo splinters just to try them in a reinforced cement column .According to the results of the investigation, the use of bamboo as reinforcement in columns does not result in an increase in overall strength; however, it does improve the ability of the column to deform (ductility). It may be used in single storey buildings when tensioning is considered, but not practical for reservoirs and other water retaining structures as it sags more and takes in water.

In 2015 V. Ashwin et.al performed analysis on deformation of bamboo reinforced concrete pillars which were done experimentally. The normal steel pillar is fabricated following a given standard. The bamboo reinforced column is made by cutting the splints of bamboo culms in accordance with the given standard. A thin layer of epoxy resin (which is a water proofing agent) is fabricated on splint so as to ensure good connectivity.The study comprises compressive and axial load tests conducted on a normal steel column and bamboo-reinforced column for purposes of comparison in results. The results show that while the ductility is improved, no increment in strength is envisaged. This type of column is perfect for short height buildings but unsuitable for dams since it has high deflection values alongside an increased moisture content in rainy seasons.

In 2014, I.K .Khan carried out an experiment to find out how bamboo would reinforce concrete beams. The main objective of this study is to compare the beams reinforced with steel and those reinforced with bamboo sticks having square, triangular or circular cross sections. The results from the lab show that buckling load carrying capacity as well as deflection of deflected beam are higher for beams having a square cross-section than those having triangular or rectangular ones.

Sani Haruna, M. Lakshmipathy (2014) conducted an experiment on bamboo reinforced coconut shell concrete beams. There were several types of beams including Normal Weight Concrete Beams (NWCB), Coconut Shell Concrete Beams (CSCB), Bamboo Reinforced Coconut Shell Concrete Beams (BCSC), and Bamboo wrapped with binding wire Reinforced Coconut Shell Concrete Beams (BCSCB). Consequently, it had been deduced that the energy absorption rate levels of bamboos when incorporated onto coconuts were relatively elevated compared to those of other materials.When compared to ordinary weight concrete beams, coconut shell concrete beams showcases greater deflection until the point of failure.

In the study conducted by Dr. Patel Pratima.A and others(2013), the main aim was to evaluate the performance of bamboo in reinforcing a structural element. The three-year-old brown coloured bamboos were chosen and from these plants, samples of 1m were taken at the base with three and five nodes. A bamboo strip is placed in the tension zone while in the double reinforced concrete panel it is placed in the compression and tension zone.

IJAMSR

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A comparative study of bamboo reinforced concrete beams using different stirrups material for rural constructions was made by Adom et.al (2011). A fully grown bamboo species Bambusa vulgaris and ratten cane species Ermospatha spp is used for reinforcement. There were different types of stirrups that were used which include: steel stirrups, bamboo stirrups and ratten cane stirrups. When compared to bamboo reinforcement, ratten canes reinforcement with steel stirrups is more expensive.

3. ADVANTAGES

a) Hence, cutting it down, fixing it, managing it along with its position and take care of do not require any advanced equipment.
b) Guadua bamboo is fit for all sorts of structures and constructions because of its physical characteristics.
c) Bamboo does not cause pollution and it never has crusts or waste parts on which one can consider as waste. Instead of increasing problems to polluting landfills similar to traditional building waste such as conventional building waste each part that do not used in the hat bamboo is recycled back to earth as manure or can be made into bamboo charcoal.
d) It is lightweight since it has a circular shape and hollow spaces. It is therefore easy to transport them when constructing building materials out of bamboo. Hence, construction using bamboo saves time.
e) Permanent buildings can be done using Bamboo as well as temporary structures.
f) Bending prevents rupturing while being bent hence in every node; bamboos have a crosswise or dividing wall responsible for its strength. This feature makes bamboo constructions more preferable during earthquakes and provides better building earthquake resistance than other types of buildings.
g) Cutting lengths from any direction by means of simple hand tools like machetes exposes the fiber structure within the walls;
h) The surface of the natural bamboo material is beautiful, clean with a fine texture without any need for painting away either scraping or polishing.

4. DISADVANTAGES

a) Bamboo has a tendency to shrink, so it might need some extra care when handling.
b) Designing and building with bamboo needs a specific skill set that not all contractors have.
c) Despite its drawbacks, the advantages of bamboo outweigh its disadvantages.

5. APPLICATIONS

The bamboo is used in construction for both Inside and Outside work Internal application includes:

- Flooring.
- Support columns.

Electrical wire coverings.
Interior wall.
Eco friendly products for kitchen and bath. External application includes:

- Structural frame.
- Corner posts.
- Girders.
- Joists.
- Studs.
- Braces.
- Tie beams.
- King posts.
- Purlins.
- Ridgepoles.
- Rafters.
- Sheathing.
- Roofing.
- Exterior walls

IJAMSR

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6. CONCLUSION

By using proper methods of harvesting and preserving bamboo, we can control how much water it absorbs and its moisture levels. If we use the Bambusa vulgarius type of bamboo, we can get enough strength to handle compression. Bamboo also adds flexibility, which is important to resist earthquakes after we use it to reinforce concrete. We can even use bamboo concrete wall panels to fill in the walls of a framed building, making the structure more flexible and resistant to shaking. Previous studies show that using bamboo instead of steel for reinforcement is not only cheaper but also effective. It's particularly recommended for single-story buildings. With its proven reliability, there's a lot of potential to use bamboo reinforcement in designing taller buildings in the future.

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