A Review of Use of Bamboo as a Reinforcement Material in Construction

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Abstract— Bamboo is a natural, economical and abundant material available in India. It having required compression and tensile strength. Mild steel is a basic material for construction used all over the world. As we know that concrete having high compressive strength but weak in tension. To overcome this steel is used as a reinforcement material to improve tension carrying capacity. The as compare to other materials steel is expensive and corrodes easily which leads to deterioration of structure. The bamboo is the proper solution to overcome this problem because of its properties like light weight, strength, durable and easily renewable. So, here in this report we suggest that without adopting the traditional method of using steel reinforcement take advantage bamboo as a reinforcement material in construction industries. In this paper we are going to compare the performance of steel and bamboo to find the optimum result.

Keywords: Bamboo, flexural strength, laminated, treated bamboo, untreated bamboo

I. INTRODUCTION

We know that giant bamboos are the largest members of the grass family. The intermodal regions of the stem of bamboo are usually hollow. The vascular bundles within the cross section are scattered throughout the stem rather than a cylindrical arrangement. We also know that Bamboo is one of the fastest growing plants in the world. Some species of bamboo can grow up to 91cm within a 24-hour period. They are of remarkable economic and cultural significance being used for building materials, and a versatile raw product of paper industry. Bamboo has a higher compressive strength than brick, wood, concrete and a specific tensile strength than concrete. Upkeep expense of a steel structure is high. We know that steel having disadvantage of rusting, so costly paints are required to re-establish it time to time. So that resistance against serious conditions increments. Steel has little resistance against flame when contrasted with cement. Just about from 600-700C portion of steel quality decreased. Steel can't be mould in any heading you need. It must be utilized as a part of structures in which segments initially exists. On the off chance that there are expansive varieties in elasticity than this lead steel to more strain.

As per the current scenario world timber demand increasing at rapid rate but the supply is depleting. As compare to other composite material, industrially treated bamboo has shown greater strength, and can be suitable for structural and non-structural application in construction. Now day's developing countries have the highest demand for steel reinforced concrete, but often they do not produce the steel to meet that demand. Ample, sustainable and extremely resilient bamboo has potential in the future to become an ideal replacement in the regions where steel cannot be produced easily. Bamboo archives the strength through its hollow, tubular structure, to resist forces in its natural habitat. Other advantage is that it is light weight structure so that it is easy to harvest and transport. Bamboo is cheap due to its rapid growth cycle and varieties of area in which it is able to grow. It requires the grass to absorb Co2. These factors can alone be incentive for investment in developing bamboo as reinforcement.

With the innovation of science and technology new methods are required for the processing of bamboo to make it more durable and more usable in terms of building material. Studies are administered on the essential characteristics and on processing of bamboo into various sorts of composite products.

Bamboo has several unique features like ability to produce fast with high yield and also it matures quickly. Additionally, bamboo can grow abundantly that too at lower cost which make it more economical. In the present exploration work the principal choice i.e., alternate construction materials with traditional construction technique had been utilize with the goal to use bamboo sticks of varied state of cross area as a replacement of steel bars in support.

II. LITERATURE REVIVE

1) Farhana Naznin et.al (2015) investigated a study on bamboo ferroconcrete beams. Bambusatulda was made into splints of 16 mm and 20 mm which are then treated Copper Chrome Boron and finally they are surface dried. Two sorts of bamboo splints are prepared–plain and tor. The tor splints alone are coated with bitumen and sand is sprinkled to extend bond strength. Steel is employed as a stirrup material for boxing of bamboo ferroconcrete which finally casted. The concrete mix and water cement ratio of required proportion is adopted. Bamboo splints are then tested for flexure, tension and moisture content. Based on results obtained, we will attain better flexural performance by increasing the number of reinforcements, diameter of the bar and shear links to the bamboo reinforced beams. The deflection within the mid span is reduced and also flexural strength is increased.
2) Ogunbiyi et.al (2015) has made a comparative analysis of the strength of bamboo and reinforcement steel bars as structural members in building construction. High yield and low-carbon steel bars of size 10mm, 12mm, 16mm, 20mm and 25mm are produced. Bamboo culms of size 10mm, 12mm, 16mm, 20mm and 25mm was made. Tensile test is conducted on all the three samples of various diameters. Based on the result obtained, we are concluding that bamboo features a very low lastingness and undergoes brittle failure when load is applied thanks to low breaking force. It used in place of partition walls, roofs other areas of light weight construction but it is not recommended for heavy engineering works.
3) Ashwin et.al (2015) conducted an experimental investigation on deformations of bamboo ferroconcrete columns. The conventional steel column is ready as per

specification. The bamboo reinforced column is ready by cutting the splints of bamboo culms as per specification. A thin coating of epoxy which may be a water proofing chemical is applied on the splints to realize good bonding. The compression and axial load tests are conducted on conventional steel column and therefore the before the bamboo reinforced column and the results are compared. Based on the results obtained, bamboo reinforced column won't increase the strength but it enhances the ductility of the section. It is suitable for low rise building and not suitable for water retaining structures because it shows larger deflection and increase in moisture content.

4) Jameskariukiet.al. (2014) they were conducted an experimental analysis on flexural strength of laminated bamboo beams. Yushaniyaalphinais a type of species in bamboo. The bamboo strips are laminated with the assistance of high strength PVA Adhesive. The bamboo is cut and splited by using pressing and splitting machine. The outer silky and soft layer is removed before being boiled and dried. It is then boiled in a solution containing hydrogen peroxide for 3 hours and preserved using preservative agent boric acid and borax oxide which are effective against termites and fungi. Finally, the water is evaporated and salts are settled within the bamboos which are dried in air for 3 months until 12% of moisture content is achieved. The six laminated bamboo beams were compared with three beams of cypress timber. Bamboo laminated beam having better load carrying capacity than cypress beam.
5) Prem kumar. V, vasuki. V (2014) conducted an in-depth study on mechanical properties of bamboo ferroconcrete beams. The experiments analysis where conducted on conventional steel reinforcement over treated and untreated bamboo ferroconcrete beams. Untreated bamboo reinforced beams are made from stirrups materials which are Thermo Mechanically Treated rods and bamboo. Treated bamboo reinforced beams are made from stirrups material which are Thermo Mechanically Treated rods and bamboo coated with epoxy (Concessive Master Index 1315) over which fine sand is sprinkled which gives high bond strength. The comparative experimental values of convention steel, untreated and treated ferroconcrete beams are taken under consideration to elucidate its durability, flexural strength, sustainability.
6) K. Khan (2014) has conducted the experimental investigation of bamboo ferroconcrete beams. In this study they compare the beams reinforced with steel and bamboo sticks of square, triangular and circular cross section. Based on the experimental results obtained load carrying capacity, deflection, flexural and shear strength of bamboo reinforced beam with square cross section is higher in comparison to bamboo reinforced beam with triangular and rectangular cross section. Hence, the lastingness and modulus of elasticity of bamboo is one half and one third of steel respectively.
7) Jigar K. Sevalia et.al (2013) has made a study on bamboo reinforced cement concrete. Tensile test on bamboo stirrups, compression test on cement concrete cubes and flexural test on bamboo ferroconcrete beams were conducted to guage the performance of bamboo. For conducting tensile test, the bamboo of length 520mm and thickness 10mm and both the ends are roughened to realize grip. For conducting compression test, the cement concrete specimens of size 150mm x 150mmx 150mm were casted and cured before testing. For conducting flexural test, three different sort of flexural beam were prepared like plain cement concrete beam without bamboo stirrups, singly reinforced cement concrete beam with two untreated bamboo stirrups at rock bottom, doubly ferroconcrete beam with two untreated bamboo stirrups provided at both top and bottom of the beam. Plain cement concrete beam fails suddenly without any warning which denotes the brittle failure. Modulus of elasticity and cargo carrying capacity is bigger in doubly reinforced beam than singly reinforced beam.
8) Sani Haruna, M. Lakshmipathy (2014) were conducted an experimental investigation of bamboo reinforced coconut shell concrete beams. The types of beam like Normal Weight Concrete Beams (NWCB), Coconut Shell Concrete Beams (CSCB), Bamboo Reinforced Coconut Shell Concrete Beams (BCSC), Bamboo wrapped with binding wire Reinforced Coconut Shell Concrete Beams (BCSCB). Based on the results obtained, energy absorbed by bamboo reinforced coconut shell concrete beams was higher than that of other beams. Coconut shell concrete beams, bamboo reinforced coconut shell concrete beams and bamboo wrapped with binding wire reinforced coconut shell concrete beams shows greater deflection until failure when compared to normal weight concrete beams.
9) H. M. A. Mahzuzet. Al (2011) made performance evaluation of bamboo with mortar and concrete. The basic sorts of sample like bamboo sample alone, composite sample of bamboo with mortar poured in its hole, composite sample of bamboo with the mixture of sand, cement and stone chips poured in its hole, bamboo reinforced column sample where bamboos sticks are used as alternative of steel. For preparing first sort of sample, bamboo which were made air dried and worm free whose length is 1'. The inter modal regions were made hollow and then soft bamboo were made perpendicular to the surface. For preparing second sort of sample, each of bamboo whose length1'is selected for testing. The hollow section of the bamboo sample is crammed with concrete. At the 16th day of curing the sample is air dried to avoid swelling and odorous problem. The curing is continued further and the sample was again air dried for two days before testing. For preparing third sort of sample, each of the bamboo samples whose length 1' is chosen for testing. The hollow section of bamboo samples is filled with sand, cement and stone chips. For preparing the fourth sort of sample, bamboo splints were made to check their effectiveness in concrete column. Based on results of compression test made on four samples, bamboo ferroconcrete column gives average stress which resists moderate load and this sort of sample is suitable for low-cost building. Composite sample of bamboo with mixture of cement, sand and stone chips poured in its hollow section gains higher strength in comparison to

composite section of bamboo with mortar poured in its hollow section.

10) Adom et.al (2011) made a comparative study of bamboo reinforced concrete beams using different stirrups material for rural construction. Fully grown bamboo species of Bambusavulgarius and ratten cane species Ermospathaspp is employed for reinforcement. Different types of stirrups like steel stirrups, bamboo stirrups and ratten cane stirrups were used. Ratten canes reinforcement with steel stirrups is costliest in comparison to bamboo reinforcement. Hence, bamboo reinforced steel stirrups were recommended to improve load carrying capacity.

III. Applications

- The bamboo is used in construction both internally and externally 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.
- Kingposts.
- Purlins.
- Ridgepoles.
- Rafters.
- Sheeting
- Roofing.
- Exterior walls.

IV. Advantages

1) As compare to other bamboo is easy to cut, repair, handle, reposition and maintain without the need for urbane tools and equipment.
2) Guadua bamboo is suitable for all types of structures and constructions due to its physical characteristics.
3) Bamboo is non-polluting and does not have crust so parts that can be considered waste. As a replacement for of adding to the problems of polluting landfills like unadventurous building waste, any part of the bamboo that is not used is recycled back into the earth as fertilizer or can be treated as bamboo charcoal.
4) Its circular form and hollow sections make bamboo a light building material, which is easy to handle, transport and store. Therefore, building with bamboo saves time.
5) Bamboo can be utilized for permanent and for temporary constructions.
6) Bamboo has a dividing or transverse wall that maintains strength and allows bending thus preventing rupturing when bent in each of its nodes. Hence bamboo construction offers superior construction for earthquake resistance design.
7) As surface of the bamboo is smooth, clean, with an attractive color which does not require painting, scraping or polishing?
8) Besides being used as a structural element, bamboo can also serve other functions such as flooring, wall paneling, water pipes, drainage and furniture.
9) Another advantage of building with bamboo is that it can be used in combination with other type of materials like reinforcing materials for foundation.

V. DISADVANTAGES

1) Bamboo tends to shrinks therefore special laundering may be required.
2) At actual designing and constructing with bamboo requires a superior skill set that the regular contractor may not possess.
3) The number of benefits of bamboo outweighs its disadvantages.

VI. Conclusion

1) Based on the previous researches it provides assurance that we can use bamboo reinforcement which is most economical and cheaper when compare to conventional steel reinforcement and it is recommended to use in single story building.
2) By using proper harvesting and preservation techniques water absorption, moisture content of bamboo can be controlled.
3) By utilizing Bambusavulgarius species of bamboo we can attain adequate compressive strength.
4) When bamboo is used as reinforcement in concrete to resist earthquake, it provides ductility.

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