

REVIEW OF BAMBOO AS REINFORCEMENT MATERIAL IN CONCRETE STRUCTURE

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Abstract: Bamboo being a grass and botanically belongs to family “*Poaceae*”. It completes its growth within month’s time and gets mature within 3 years. In Maharashtra it is commonly named as “*velu*”. Species of bamboo change as per topography and climatic conditions. It has good tensile and compression strength. As per review *dendrocalamus strictus*, *bambusa vulgaris schard* are species of bamboo which has highest value of tensile and compression strength. Problems faced in using bamboo as construction material are water absorption and moisture content. To avoid this problems proper seasoning or treatment should be given to bamboo. In this paper test results on mechanical, physical properties as well a bamboo reinforced column & beams are reviewed.

Key words: ‘poaceae’, ‘velu’, topography and climatic condition, tensile and compression strength, water absorption, moisture content, seasoning, mechanical & physical properties.

I. INTRODUCTION

The development of science & technology is a continuing quest for improvement in infrastructure of world around us. The structures in nature are great lessons for human study only the most eco- friendly structural forms have survived. The profound capacity respond to a variety of climatic and environmental forces, makes a natural form of tremendous examples to numerous fields of structural design.

A natural material which is available in bulk and ease of use in the rural areas in the developing countries is bamboo. Bamboos occur mostly in tropical and subtropical areas, from sea level to snowcapped mountain peaks, with a few species reaching into temperate areas.

The major application of bamboo is for construction and housing. According to study it is estimated that one billion people in the world live in bamboo houses. Since bamboo has been used in construction and currently they are used as props, foundations, framing, scaffolding flooring, walls, roofs and trusses. Bamboos are tied together to make grid reinforcement and placed in soft clay to solve deformation problems in embankments. In rural part of India mostly bamboo is use as reinforcement in mud walls.

II. REVIEW

During the past few years, several researchers have found new materials for structural purposes in civil engineering. This section mostly defines about the natural fiber utilization as reinforcement and a convenient option for HYSD bars.

The investigation reported in International Network for Bamboo and Rattan (INBAR) (2002) suggested bamboo’s advantages and disadvantages as a constructive material. The advantages of bamboo are ecological value, good mechanical properties, social and economic value, and energy consumption. The other sides, the disadvantages of bamboo are preservation, fire risk, and natural growth. [1]

Amada and Untao (2001) mention that bamboo is the most effective material in construction by the superior character of bamboo such as being physically powerful, tough, and a low-cost material. Normally, the Culm of bamboo with outer surface layer withstand strongly to any loading with stronger fracture resistance than the node. It suggests that the fibers in the node do not contribute any fracture resistance. The tensile strength of bamboo fibers almost corresponds to that of steel. The main discovery is that the fracture properties of bamboo depend upon the origin of fracture. In the nodes, it is found that the average fracture toughness is lower than the minimum value of the entire Culm, suggesting that the fibers in the node do not contribute any fracture resistance [2].

Ghavami (1995) studied bonding and bending with bamboo in lightweight concrete. Most developing countries have several problems, and one of the main problems is housing. The housing problem has been related to lack of

research in field of low cost housing projects. Scientists, engineers, and designers need training and education for finding low cost construction and efficient plans. In additional, specialist systems for education, various information, and vitality of economy are needed.

The values of the test of compression and shear are dependent on the type of bamboo. The tensile strength is higher than the compression strength with the compressive range 12 to 53MPa. In several tests, *Bambusa vulgaris* schard and *Dendrocalamus* were researched the highest value, 141 and 124 MPa. The compression strength was observed as 40~62 MPa for specimens 120 mm length and 10 mm width.

The bond test considered two types of bamboo, treatment and untreated. The treated specimens were wrapped with 1.5mm steel wire on embedded 40mm spacing and cared Negrolin-sand. In this test, treated bamboo, 0.97 N/mm^2 , was more effective than untreated bamboo, 0.52 N/mm^2 , with up to 90% improved bond stress. [3]

Ghavami (2005) coordinated reinforcement properties of bamboo in concrete. Due to growing problems in the environment, many countries recognize the importance of environmental specifications. A lot of materials used in industry are turned to nonpolluting materials such as natural sources, bamboo, water, recycled materials, and agriculture for engineering applications.

To improve the bond strength between bamboo and concrete, three factor of impermeability treatments were used to the bamboo. First was the adhesion properties of the substance applied to bamboo and concrete, second was the water repellent property of the chosen substance, and last one was the topography of bamboo and concrete interface. The effective treatment of the three types was water repellent treatment with a thin layer of epoxy. [4]

Atul agarwal and Damodar maity (2009) they studied axial compression and bending test was performed on Plain, Steel & Bamboo reinforced members. As explained in there experimental program, For example, a total of 12 columns (150x150x1000mm) were casted using design mix (M20) as per IS code. These columns included 3 columns of steel reinforcement, 3 columns of plain concrete, 3 columns of untreated bamboo reinforcement & 3 columns of treated bamboo reinforcements (with varying percentage of reinforcement; i.e. 3, 5, & 8%). The load-deformation curves displayed significant nonlinearity, indicating that the bamboo has the capacity to absorb energy. Failure of Columns predominately occurred in shear in shear under compressive loading.

Plain concrete and untreated bamboo columns showed brittle behavior in which, tiny cracks occurred at the surface of the column at about 80% of maximum axial force. After reaching the maximum load, the load capacity decreased abruptly and it finally failed in few seconds. There were no visible signs of spoiled concrete covering to warn of impending failure.

Whereas in steel and bamboo reinforced columns more ductile behavior was observed, wherein tiny cracks became visible at surface of columns firstly at 80-90% of maximum axial force. Final failure was accompanied by growing signs of cracks and spalling of concrete. Furthermore, the results, exhibited that the maximum load carrying capacity of steel reinforced (min reinforcement, 0.8%) column is nearly equivalent to that of treated bamboo (8% reinforcement) reinforced column (owing to the strength of bamboo samples).

Transverse load test performed on above set of columns revealed the lateral deflection, strain characteristics and failure mode pattern of the steel, plain and bamboo reinforced columns. Hence, further analysis of results obtained, would assist in evolving comprehensive design methodology in case of reinforced columns.

Bamboo concrete composite structural members can provide tailored solutions to the eco-housing initiatives at cheaper costs. The results obtained accrue the advantage obtained by the composite members when compared to standard reinforced concrete and plain concrete. However, further studies to achieve higher mechanical properties and understanding their behaviors in details would make this a reality. [5]

Efe Ewaen Ikponmwsa (jan 2011) The tensile stress of seasoned bamboo is about 70 N/mm^2 , about one-third of that of steel, with low ductility and a total strain of 5% compared with an average strain in steel of 12%. The use of bamboo-strip as reinforcement in concrete column increased the load carrying capacity of the column compared to unreinforced concrete. It also improves the post cracking ability of the concrete but not as pronounced as in steel-reinforced column. Increase in volume content of bamboo strip reinforcement in the concrete section does not correspond to increase in the ultimate strength but only enhanced the ductility of the section. Failure mode is independent of the materials used for reinforcement but rather on the strength of the reinforcement/concrete matrix. Hence, attention should be on enhancement of the reinforcement/concrete matrix bond. The bamboo-strip reinforced column shows excessive cracking and deflection especially 12No.-strips. [6]

Harish Sakaray, N. V. Vamsi Krishna and I. V. Ramana (Jan-Feb) 2012-The constitutive relationship of the nodes differs from those of inter-nodal regions. Further the nodes possess brittle behavior and the inter-nodal regions

possess ductile behavior. The average tensile strength of moso bamboo from present study is 125N/mm^2 , which is half the strength of mild steel.

There is no failure pattern followed by samples in tensile test. However, the samples with nodes generally failed at higher loads than those samples without nodes. The compressive strength of bamboo is nearly same as the tensile strength of bamboo and this behavior is similar to steel. Bond stress of bamboo with concrete is very low compared HYSD steel bars, due to surface smoothness of bamboo.

Water absorption of bamboo is very high and waterproofing agent is recommended. From the test conditions, bamboo can potentially be used as substitute for steel reinforcement. As bamboo is eco-friendly material, limiting the use of steel can reduce carbon dioxide emissions. In the green building concept use of bamboo reinforced concrete may be recommendable. [7]

M.R. Wakchaure and S.Y. Kute (feb 2011) - Moisture content of bamboo varies along its topography and with seasoning period, which affects all physical and mechanical properties. It is one of the important factors in deciding the life of bamboo. The author made experimental investigations to evaluate the physical and mechanical properties of the bamboo species *Dendrocalamus strictus* and its utilization potential as building material may be as whole or in the split form. In the present study moisture content, specific gravity, water absorption, dimensional changes, tensile and compressive strength at different height location are worked out. The moisture content varies along the height for green bamboo or at any time after harvesting. The top portions had consistently lower moisture content than the middle or basal at all stages of seasoning. Specific gravity on oven dry mass basis decreases from top to bottom and is independent of moisture content. Water absorption is inversely proportional while dimensional changes, tensile and compressive strength are directly proportionate to moisture content. [8]

III. DISCUSSION

Bamboo has excellent engineering properties and can be utilized for low cost housing project. It can mainly be used as reinforcement to the structure. Drawback of bamboo as construction material is its water absorption and moisture content properties. This mainly affects its strength. To reduce this effect seasoning and proper coating to bamboo should be done before using it for reinforcement.

IV. CONCLUSION

1. Water absorption of bamboo is quite high. To reduce this effect seasoning or other suitable treatment should be given.
2. Tensile strength of bamboo is good and can be used as reinforcement in R.C.C structure for low cost housing project.
3. Compression strength of round bamboo ranges from 47.9 to 69.9 Mpa. As per review *dendrocalamus strictus* and *Bambusa vulgaris* scharde have highest compression value.
4. As bamboo is weak in shear it cannot be used as shear reinforcement in R.C.C structure.
5. Moisture content of bamboo changes according to topography and climatic condition. Moisture content directly affects the strength of bamboo.
6. According to study by researchers in world, in next 60 years steel production will be reduce hence a utilization of natural and eco friendly options like bamboo should be used.
7. Bamboo is weak in bond stress hence it should be treated by epoxy coating, tar coating etc.
8. Bamboo shows ductile behavior as in steel. Hence it can be use as compression members in steel as well as R.C.C. structure.
9. Bamboo is weak at node section major failure in bamboo occurs at node.

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