Comparative Study of Bamboo Reinforced Beam With Steel Reinforced Beam Using Ansys

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Abstract- *India has the world's 17.71% population. It thereby holds the second position among countries on population count. As India is a developing country, such a large population needs high infrastructure development on account of which construction works are continuously going on. Also, the Indian government has initiated many new projects under the scheme "Housing for all 2022" to provide houses to the country's underprivileged society unfortunately, the production of every ton of cement and steel releases at least one ton of CO2. To fulfil the requirement of this scheme, sustainable and economical construction is preferable. Also, as we can see in the current environment scenarioironment, Air Quality Index (AQI) contiworsen dailyay by day due to pollution created by construction industries involving the building of structures with concrete and steel. This project incorporates Bamboo as eco-friendly, economical and readily available structural material because of its environmental edge over conventional materials, such as its high strength and low density.*

Keywords- Design of Bamboo reinforced, Bamboo reinforced,

I. INTRODUCTION

Globally, the iron and steel sector is the second-largest industrial user of energy, consuming 616 million tons of oil equivalent (Mtoe) in 2007, and the most significant industrial source of Carbon dioxide (CO2) emissions with 2.3 Giga tones of CO2 (Gt CO2). India's iron and steel sector is the largest industrial user of energy in India, consuming 38 million tons of oil equivalents (Mtoe) in 2007. It is also the most significant industrial source of carbon dioxide (CO2) emissions, with 151 million tons of CO2 (Mt CO2).

There is an urgent need to use naturally occurring products as a construction material to decrease the growth of energy consumption and CO2 emissions replacement of Bamboo in place of steel is widely recognized as one of the most important non-timber forest resources because of the high tensile strength and socio-economic benefits with bamboo-based products. Bamboo has been used as a construction material in certain areas for centuries.

1.2 Brief History of Bamboo

The word Bamboo is said to originate from Malay, which is the primary national language spoken by Malaysian and Indonesian people. However, the grass itself originated from China. This is the place where the first use of Bamboo was recorded. However, many other parts of the world have adopted it as a plant because of its diverse use cases. Bamboo is a beautiful construction material that is increasingly used in houses and structures. You'll discover sustainable flooring alternatives, island-inspired furniture, rustic décor, and more when looking for bamboo items. For millennia, cultures have utilized Bamboo for a variety of reasons. Some of their creative Bamboo uses influenced how we utilize Bamboo now.

1.3 Bamboo Characteristics

This is because Bamboo is subjected to maximum bending stress due to wind at the top portion of the culm (Ghavami 2004). Bamboo is a natural Functionally Graded Material (FGM). It is a composite with a hierarchical structure. The strength of Bamboo is more significant than most the timber products

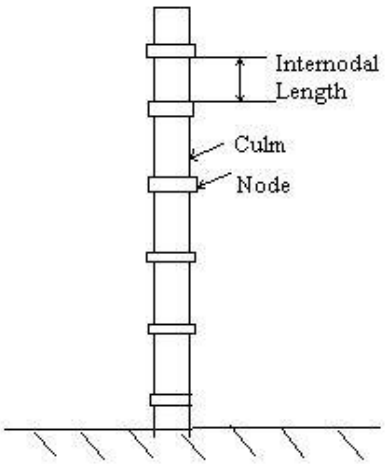


Figure. 1.1 Whole Bamboo Culms

The mechanical properties vary with height and age of the bamboo culm. Research findings indicate that the strength of Bamboo increases with age. The optimum strength value occurs between 2.5 and 4 years.

1.4 objectives

- To determine the modular ratio.
- To check whether it is safe in deflection or not.
- To achieve economy in construction.
- To decrease dead load of structure.
- To promote Bamboo as a reinforcement material.
- To reduce Carbon dioxide emission in the environment

1.5 problem statement

Many researchers have investigated the application of Bamboo as reinforcement in concrete in the past decade, and also investigation has been done to find out various mechanical properties and their application to promote the Bamboo as reinforcement, and they found that substituting Bamboo with steel will help in economic construction

But significantly less work has been done towards deciding the actual deflection of Bamboo reinforced concrete and steel reinforced concrete and finding a modular ratio. This project aims to find modular ratio add to check deflection to see its safety.

1.6 Scope

Bamboo being economical to use as construction material and this project aims to decide modular ratio of bamboo reinforcement which will be further helpful in designing the low-rise building. Steel being non- renewable resource one day it will be on verge of extension; hence there is a need to find material to substitute the steel to reduce the burden on steel requirement. This project will help to find a way to use Bamboo as a substitutive material. In the upcoming year, it has many applications in the construction of various structures which aim to reduce the load on the system and cost.

1.7objectives of the research

Whereas the mechanical properties and behaviour of steel reinforcement have been thoroughly studied and well documented, no comprehensive data exists describing bamboo reinforcement. Therefore, this study aims to provide a preliminary contribution toward collecting the mechanical properties and behaviours of bamboo reinforcement. Some of the previous research is mentioned in connection with this.

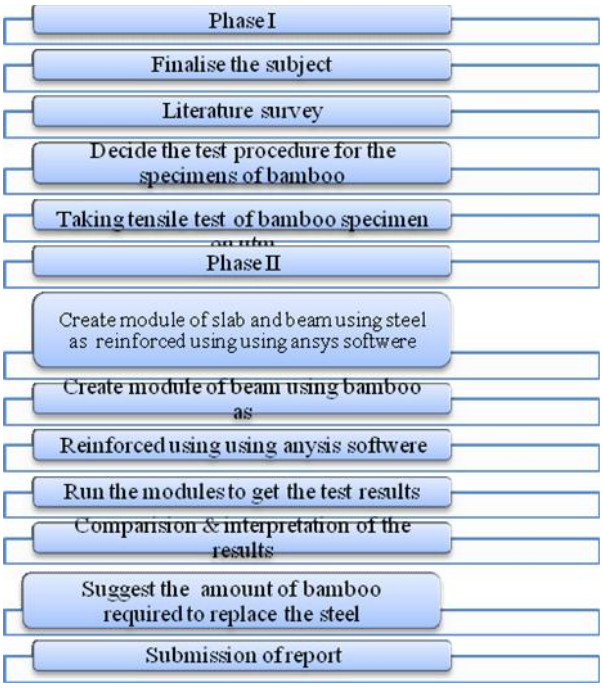
The mechanical properties vary with the height and age of the bamboo culm. Research findings indicate that the strength of Bamboo increases with age. The optimum strength value occurs between 2.5 and 4 years. The power decreases at a later age.

1.8 Tensile test results & setup

Fig.1.2 tensile test setup

II. METHODOLOGY

2.1 Project Plan



Tensile test

To obtain the tensile strength of Bamboo, the bamboo specimen should be properly selected following points should be considered while selecting bamboo culms for use as reinforcement in concrete structures.

3.1Selection of Bamboo

- Use of Bamboo showing a pronounced brown colour. This will ensure that the plant is at least three years old.
- Select the longest large-diameter culms available.
- Do not use whole culms of green, unseasoned Bamboo
- Avoid bamboo cut in spring or early summer. These culms are generally weaker due to increased fibre moisture content.

3.2Testing

The tensile tests were conducted for several samples of both bamboo and bamboo twig specimens. The following section will discuss their failure pattern and ultimate and yield strength. Tension tests were performed for examples with different conditions of gripping. Proper gripping is an essential factor for the tensile test. Bamboo is a relatively soft material than the materials used for gripping purposes in UTM. At the time of tension tests, early failure was observed at the gripping end, possibly due to high stress developed from lateral compression.

Moreover, the surface of the bamboo specimen is very slippery; therefore, the samples, in some cases, experienced slipping at the time of the tension test. GI wires (2mm diameter) were wrung spirally at both ends of the specimen to solve these gripping problems. The application of GI spiral around the fortunes of the bamboo specimen.

Fig. 3.3 Bamboo culm with end preparation

Materials properties

The characteristics of the "A3" beam and the real properties of materials are presented in Table 1. It is noteworthy mentioning that this study also considered other configurations for the connectors, as number, height and diameter. Materials properties of composite beam were as follows,

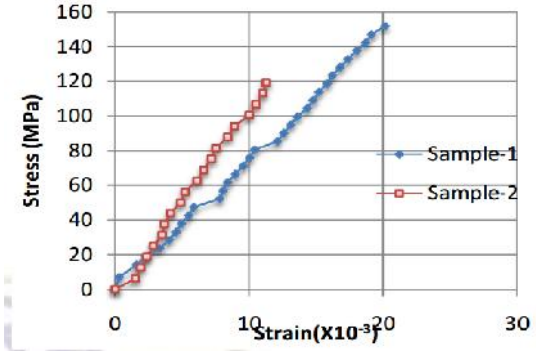
Sr.No.	Material	Property	Value
2	Reinforcing bar	Yield stress (MPa)	250
		Ultimate strength (MPa)	350
		Young's modulus Es (MPa)	$200*10^3$
		Poisson's ratio μ	0.3
		Ultimate strain e	0.25
3	Concrete	Compressive strength (MPa)	42.5
		Tensile strength (MPa)	3.553
		Young's modulus Ec (MPa)	25000
		Poisson's ratio μ	0.15
		Ultimate strain e	0.045
4	Bamboo reinforcement	Yield stress (MPa)	101.08
		Young's modulus Es (MPa)	1000
		Poisson's ratio μ	0.35
		Ultimate strain e	0.012

Material modeling

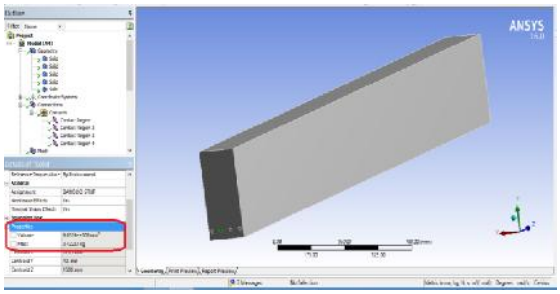
The definition of the proposed numerical model was made by using finite elements available in the ANSYS code default library. SOLID186 is a higher order 3-D 20-node solid element that exhibits quadratic displacement behavior. The element is defined by 20 nodes having three degrees of freedom per node: translations in the nodal x, y, and z directions.

The element supports plasticity, hyper elasticity, creep, stress stiffening, large deflection, and significant strain capabilities. It also has mixed formulation capability to simulate deformations of incompressible elastoplastic and fully incompressible hyper plastic materials.

2.2 Result& discussion



According to the statistical results, the average compressive strength, elastic modulus, and ultimate strain of bamboo scriber are 87.4 MPa, 12.1 GPa, and 0.060, respectively, and the average values of Ec 2/Ec 1 and f 0/fcu are 0.004 and 0.75, respectively; for laminated Bamboo, the average compressive strength, elastic modulus, and ultimate strain are 80.4 MPa, 120.1 GPa, and 0.060, respectively.



2.1 density of steel and Bamboo

Bending stresses

BENDING STRESS	
STEEL R/F	BAMBOO R/F
1.25E+08	1.02E+08

Fig.2.2 comparative shear stresses of steel with Bamboo reinforced concrete

Under a four-point load, the flexural strength of bamboo-reinforced concrete covering slabs with 1.00 mm x 2.00 mm and 100 mm x 0.00 mm meshing was evaluated. The outcome of comparing steel flexural strength Compared to bamboo meshing, steel reinforcements provide greater flexural strength. Stronger than bamboo meshing with a 4.00 per cent difference for 2.00 mm x 1.00 mm. mesh opening and 2.00 per cent for the mesh opening size of 0.00 mm x 0.00 mm.

IV. CONCLUSION

Based on the experimental studies presented in this paper, the following conclusions can be drawn:If tension tests are conducted without specimen end preparation, actual results may not be found due to smashing at the grip location.In general, sample failure was accompanied by tension failure for bamboo specimens.The bamboo specimen shows some nonlinearity before its collapse. Bamboo may be efficiently utilized as a substitute for steel reinforcement in concrete, as it is eco-friendly and cost-effective. Table: The ultimate load and strength of the specimen tested.

This study compares an RCC beam with bamboo strips in the first stage. Several case studies are analyzed to identify the design pattern of bamboo reinforcement as there is no code provision for these. Experimental tests were carried out to determine the material properties, such as ultimate stress and ultimate strain, using the tensile test. After the tensile test, the Finite element analysis model is prepared using ANSYS, and the following conclusions are made:

- The density of Bamboo was found to be less than steel; hence self-weight of the structure reduces
- The modular ratio is found to be 29.59
- Deflection is within permissible limits
- It helps in reducing carbon emissions since Bamboo is naturally available.

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