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# EXPIREMENTAL STUDY ON BAMBOO REINFORCED BEAM

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**Abstract -** *In the present era, Concrete is the most absorbed construction material in the whole world. Concrete is found to have finest compressive strength however poor in tensile. The aimless infrastructural development is effecting the environment. Steel which is costly, un economical and increase in CO2 emission is being used in construction, replacing with bamboo can reduce the effect on environment by using eco-friendly material.*

*This project deals with the value of bamboo as a structural element in flexure. The fresh green bambusa bamboo is treated by broucherie technique making bamboo dry and moisture free, reinforcement crate has been created using steel and bamboo stirrups. The flexure test was carried out on the beams and MOE (modulus of elasticity) has been determined.*

*Key Words*: Bamboo stick, Bamboo stirrups, steel, loading frame, strengthening, flexural strength, cracking load, ultimate load and deflection.

## 1. INTRODUCTION

Bamboo is a giant grass having a place with the group of the Bambusoideae. It is assessed that around 1100-1500 species of bamboo exist and there are additionally around 600 diverse plant types of bamboo on the planet. In this study fully grown Bambusa bamboo has been used as reinforcing material. Upkeep expense of a steel structure is high. Because of activity of rust in steel, costly paints are required to re-establish 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 steel loses its pliability property, than odds of weak breaks increment. On the off chance that there are expansive varieties in elasticity than this lead steel to more strain.

The expense of development materials including steel is expanding consistently throughout the years and houses are getting to be excessively expensive for basic man. Subsequently keeping in mind the end goal to give safe house to urban poor of the general public it is important to go either for exchange development materials with routine development procedure or to embrace ordinary materials with substitute development method to decrease the expense of structure. In the present exploration work the principal choice i.e. alternate construction materials with traditional construction technique had been utilized with the goal to use bamboo sticks of various state of cross area as a substitute of steel bars in structural member.

## 2. METHODOLOGY

Ordinary Portland cement of 53 grade is used of specific gravity 3.15. M25 grade of concrete is used of mix proportion 1:2.2.892, 12mm dia bars of Fe415 grade are used for top and bottom reinforcing. 10mm dia bars of Fe415 grade are used for shear reinforcement as vertical stirrups.

Longest and wider diameter of bamboo is more preferable. The selected bamboo is treated by boucherie treatment.

Boucherie treatment: The fresh and completely grown bamboo was cut, treated and dried in IWST Bengaluru under the guidance of Dr.vennmalar

Procedure: A freshly cut green bamboo with all the branches present is used for this test. The diameter of the cut end of bamboo is measured and fixed to similar outlet valve with airtight so that liquid should not leak. Preservative containing boron compound is poured into cylinder. The electric motor is started and pressure is induced slowly and gradually. The outlet valve is open to which bamboo end is fixed and others valve are kept closed. As pressure reaches to 25 psi the liquid starts flowing through the bamboo and its branches. Sap starts coming out from the other end within 10 minutes and it takes around 1 hour for preservative to come out. Once the treatment is over, the bamboo is kept in dry place for two to three weeks for drying. After 2-3 weeks bamboo is ready for using bamboo as a strengthening material

The treated bamboo is split by knife or by machine, the bamboo split can be used as reinforcement.


Figure 1. Details of broucherie instrument

Figure 2. Preservative coming out from the opposite end

Total 4 beams were designed such that steel is replaced with bamboo, here steel is replaced bit by bit i.e. 0% to 100%. Fourth beam replaces steel by 100% of bamboo.

Reinforcement details are as follows

Beam A: top and bottom reinforcement steel with steel stirrups

Beam B: top reinforcement as bamboo and bottom reinforcement as steel with steel stirrups

Beam C: top and bottom reinforcement are bamboo with steel stirrups

Beam D: top and bottom reinforcement are bamboo with bamboo stirrups

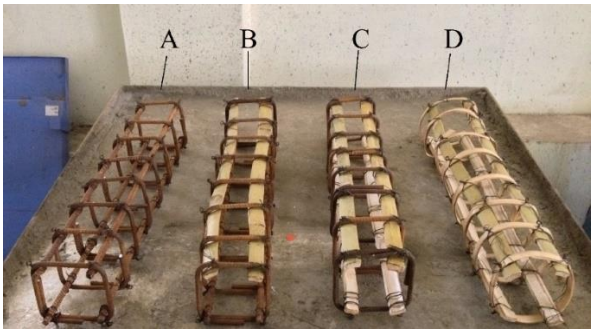



Figure 3: reinforcement details

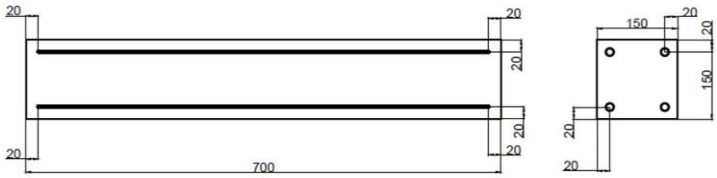
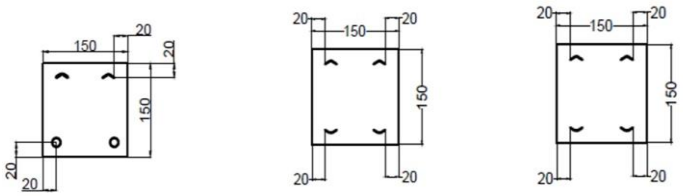



Figure 4: schematic representation of bamboo reinforcement BEAM A




BEAM B BEAM C BEAM D

## 3. EXPIREMENTAL STUDY ON BAMBOO REINFORCED BEAM

3.1 Physical and mechanical properties of bamboo

3.1.1 Tensile test on bamboo

The tensile test was performed on the bamboo splints to find out the ultimate tensile strength of treated bamboo splint. Tensile test is necessary to perform on the bamboo to check weather bamboo can sustain the tensile loads in concrete, when bamboo used as reinforcement in structural member. Totally 6 bamboo splints were tested under tensile test in which 3 bamboo having node in between and other 3 bamboo with node at edges.

Tension test carried out on bamboo splints has shown elastic behaviour, the ultimate tensile strength of bamboo splints was found to be 190 $N/mm^2$ with centre node and 212 $N/mm^2$ with node at edges.

figure 5: tensile test on bamboo

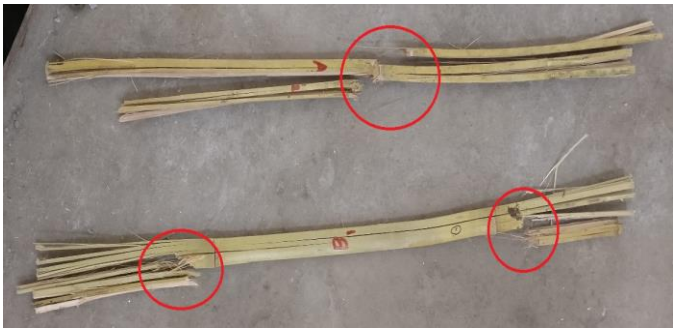


Figure 6: Failure of Bamboo by Tensile Test

3.1.2 Compression test on bamboo

The compression test was performed on the hallow bamboo culms to find out the compressive strength of bamboo. Totally 6 types of bamboo were selected for the test, in which 3 bamboo culm contain node at centre and 3 bamboo culm without node. The culms were so selected that bottom, centre and end part of the bamboo were present, the average height of bamboo culm was 150mm. compression test carried on bamboo culms showed higher compressive strength of 120Mpa.

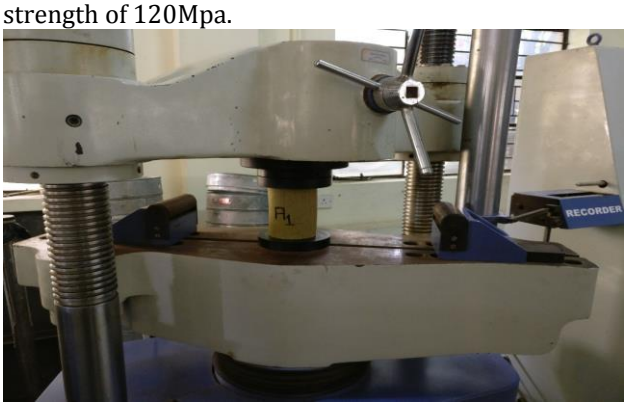


Figure 7: compression test on bamboo

Figure 8: failure of bamboo by compression test

3.1.3 Density test on bamboo

Density test was carried out to determine the compactness of a substance, where density of bamboo is used as a suitable criterion for classification of bamboo. Because its properties depends upon the green volume and oven dry mass. For every 1metre one sample was taken, totally 12 samples were selected for the test with 2.5X2.5cm dimension with varying thickness. The initial weight was taken by water displacement method, once the weights are known, samples are kept in oven for 24hours at 1000c. After 24 hours dry mass of the samples are noted down and density is calculated by below formula. The density of the bambusa bamboo lies within 0.498 to 0.826

Mass per volume $=m/v$


Figure 9: samples for density test

3.2 Tests on concrete

3.2.1 Slump test on fresh concrete

The slump test was carried on M25 grade of normal fresh concrete. The slump test is carried to determine the workability of the concrete and check weather water is properly mixed with cement. The slump of fresh concrete was found to be 100mm.

3.2.2 Compression test on cubes

The compression test was performed on the concrete cubes of M25 grade to determine the compressive strength. Total 6 cubes were casted in the mild steel moulds of size 15X15X15cm. The cubes were casted and kept for curing after 24 hours of casting. Tests were conducted on 3 cubes for 7 days and next 3 cubes on 28 days. The compressive strength of cube at 7 days was 20.12 N/mm$^2$ and at 28 days was 33.77 N/mm$^2$.

Figure 10: Test Setup to check Compressive Strength

## 4. EXPIREMENTAL RESULTS

BEAM RESULTS

This test was carried out in dayananda Sagar College of engineering Bangalore using loading frame of 50 tonnes capacity.

The bamboo reinforced beams are tested in loading frame of capacity 50 tonnes by two point loading. Initial markings are made on the beam before placing it in loading frame such as 1/3rd from the supports leaving 50mm clear span.

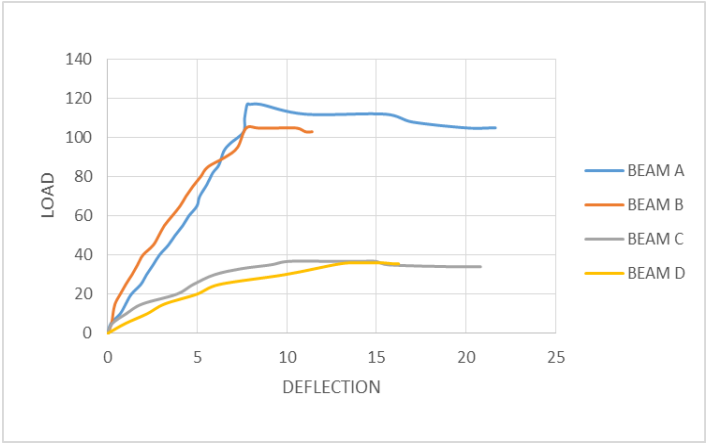

Figure 11: loading frame setup

**Table 1: specimen details**

| Specimen | BEAM A | BEAM B | BEAM C | BEAM D |
|---|---|---|---|---|
| Load at initial crack (kN) | 31.7 | 25.6 | 19.6 | 7.2 |
| Ultimate load(kN) | 109 | 104.9 | 36.80 | 36 |
| Max deflection (mm) | 21.64 | 14.42 | 20.81 | 16.24 |

Figure 12: Beams Ready for testing

Figure 13: Loading frame setup Figure 14: Flexure failure of beam




From the above graph, it is clearly showing the pattern of cracking and the failure of differently reinforced beams.it also explains the behaviour of beams under the stresses. BEAM B found to be more successful and can be used as singly reinforced beam

## 5. CONCLUSION

Boucherie technique of bamboo treatment found to be profitable and can be used in future works. Compared to treated bamboo, water absorption for untreated bamboo is high, hence can be reduced by broucherie treatment method.The density of the bambusa bamboo lies within 0.498 to 0.826. Tension test carried out on bamboo splints has shown elastic behaviour, the ultimate tensile strength of bamboo splints was found to be 190 N/mm$^2$ with centre node and 212 N/mm$^2$ with node at edges. It is observed that the nodes at the end possess a brittle behaviour and the

nodes which are internal regions are shown with a ductile behaviour. Compression test carried on bamboo culms showed compressive strength of 140Mpa, which is relatively higher. The compressive strength of bamboo culm with node is found greater than without node. The shear strength of the reinforced bamboo sections is comparatively lower than that of the completely steel reinforced beams. Bamboo reinforced beam can be used as a structural member for low cost housing and recommended for single storey building. Replacement of steel with bamboo in a larger amount will make the structure lighter as the percentage of bamboo reinforcement that has to be given increases and the density of bamboo reinforced concrete beam decreases. As this is a lighter structure it will be less vulnerable to earthquake loads. Replacement of steel by bamboo makes the structure most economical and making easy to lower-income families to build their houses.

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**IS CODES**

IS: 6874-2008 METHOD OF TESTS FOR BAMBOO

IS: 8242-1976 METHODS OF TESTS FOR SPLIT BAMBOOS

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