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A Study on Bamboo Reinforced Concrete Slabs

Maruthupandian.G[1*], Saravanan.R[2], Suresh Kumar.S[3], Sivakumar.B.G[4]
[1]Dept of Mechanical Engg, Akshaya College of Engineering and Technology, Coimbatore- 642109.
[2]Dept of Mechanical Engineering, Jawahar Engineering College, Chennai- 600093.
[3]Dept of Mechanical Engineering, Panimalar Polytechnic College, Chennai - 600029.
[4]Dept of Mechanical Engg, Golden Valley Integrated Campus, Andhrapradesh-517325.
***Corresponding author: E-Mail: maruthupandian90@gmail.com**

ABSTRACT

Polymers synthesized with synthetic fibers are more advantageous as Compared to conventional construction materials. In spite of the widespread use there is a tendency to decline because of its costs and environmental impacts. On the other hand natural fibers are less costly, light weight, and easily recyclable. Among multiple fibers bamboo is one such fibers, because of its low cost, and weight, with it short growth cycle. In this work three different compositions of bamboo reinforced polymer composites (40, 30 and 25% of bamboo reinforcement volume) are prepared with the use of epoxy and hardener. From the testing results it clearly revealed 25% of bamboo reinforcement composite had higher tensile strength among all the three. Simultaneously the bamboo is reinforced in concrete cement slab instead of steel rod with the standard size. The steel reinforced concrete slab is slightly superior to the bamboo reinforced concrete slab. At the same time deflection of both slabs are same at 40KN load. Hence the bamboo as a structural material in the minimal loading applications like kitchen slabs, books slabs can be served.

KEY WORDS: Bamboo, Concrete slab, Deflection, Steel rod.

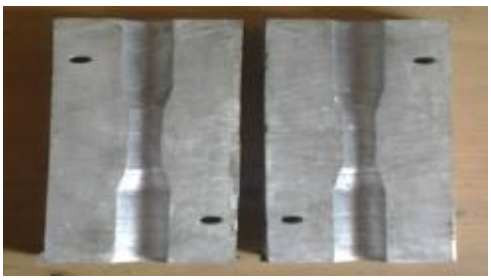
1. INTRODUCTION

Generally steel is used in the structural materials. But steel has some disadvantages like its corrodibility, high cost and also fabrication of steel leads to the release of CO2 in the atmosphere. On the other hand, composites have shown its advantages like light weight, recyclability and its cost effectiveness. (Mei-po Ho, Kin-Tak Lau, 2012) In his work, woven glass fiber and chopped silk fibers are used to fabricate the hybrid composites. From the results Young's modulus is found to increase with the use of 0.3 wt%, 0.4 wt% of the silk fiber. The Young's modulus decreases when the amount of silk fibers increases beyond 0.4 wt%. Furthermore, impact test was conducted, and the results showed that increasing the amount of silk fibers in the composite results in increasing the maximum load. When the content of silk fibers increased beyond 0.5 wt%, it is found that the maximum propagation energy decreases significantly. (Vemuvaraprasad and Mattam Lava kumar, 2011) In his work, specimen for tensile test and chemical test was prepared by using alkali treated bamboo fibers. In each case ten pre weights of samples was prepared and then dipped in the chemicals. The final weight of the samples and % weight loss /gain was determined. From the results the tensile properties and resistant to chemicals are found to be higher when alkali treated bamboo fibers were used in the hybrid composites. (Yushun Li, 2012) They prepared a lightweight bamboo–steel composite slab composed of the cold-formed thin-walled steel channel and the bamboo plywood sheathings. Three types of specimens were investigated, which are adhesive bonding, self-tapping screw enhanced connection and stability improved connection with bamboo laths glued on the both sides of cold-formed steel channel. Tests are carried out by applying the constant step loading and compared with the theoretical deformation values. (Khosrow Ghavami, 2005) In his work, characteristics of bamboo is studied in terms of modulus of elasticity and density using the material selection method. From the literature survey Bambusa Bamboos species can be used as a reinforcement material for the slab.

Thus our aim is to fabricate the tensile test specimen according to the ASTM D638 standard for plastics by epoxy based polymer composite (40%, 30% and 25% of bamboo reinforced volume) and to evaluate the tensile strength of these polymer composites. Furthermore fabricate the steel and bamboo reinforced composite concrete slab and to compare load withstanding capacity and deflection of both slabs.

2. EXPERIMENTAL PROCEDURE

Bambusa bamboo's is one of the medicinal plants, which grows well in sandy loam and fertile soil with tropical to sub-tropical climatic conditions. The Bambusa bamboos species which is used in this work was confirmed by Agriculture University Coimbatore. After testing it is then treated with Alkali as shown in Figure 1. Alkali treatment allows better fiber wetting and removes cementing substances and also it removes waxes and oils from the surfaces. The alkali used where 1.5N Noah by dissolving 60g per liter distilled water. The matrix material used was LY 556 for composite fabrication and hardener used here is HY-951.


a

b

c

Fig. 1a, b, c Bamboo materials distilled with 1.5N Noah solution, Die for making tensile specimen, Bamboo reinforced polymer composites of varying compositions

The tensile test specimen was prepared by using the aluminum die as in Figure 1b with the ASTM standard D638. Initially the mixture of epoxy LY 556 and the hardener HY 951 with the ratio of 1:10 was prepared and mixing is made with the bamboo material by stirring at room temperature. After proper stirring for 10 minutes, the mixture was poured into suitable moulds to obtain a dog bone shape and the composite is cured for 8 hours. After curing the bamboo reinforced polymer composite is removed from the aluminum die. Three different bamboo-reinforced epoxy composites were fabricated by changing the amount of reinforcement as in Figure 1c. ASTM D638 standard testing methods were used for tension testing of plastic materials.

Fabrication of Slab: A mould box was prepared by the size of 1005mm × 1005mm × 102mm with the help of wood material. Before placing the concrete in the mould box oil or grease is applied on inside surface, to make it easy to remove them once the concrete has set. The steel rods are accurately cut by 1m from the length rod with the size of 8mm and 10mm diameter. Then steel reinforcement mat was prepared by winding the steel rods with spacing of 250mm and giving the 300mm center to center spacing of steel rods as in Figures 2a.Simultaneously bamboo sticks were dried in the atmospheric temperature for three days, with the size of 8mm and 10mm square stick and 1m length bamboo stick. To prevent from the corrosion, a epoxy layer coating is made and cured for 12 hours as in Figure 2b.


a

b

Figure. 2a & 2b steel and bamboo reinforced mat

Preparation of a Concrete Mixing: Measure the quantity of sand and cement required and mix the sand and cement together until the mix has a homogeneous colour. Form a hollow in the middle, slowly add a little water in the hollow and moisten part of the mix. Repeat adding water little by little until the whole mix is moistened (i.e.) in plastic consistency. The mixture should have a firm, smooth appearance and also it should sit on a trowel cleanly. After concrete mixing the Steel & bamboo reinforcement mat is placed 15mm above from the face of the concrete bottom surface. After placing the concrete mixture of 1: 2: 4 (cement: sand: aggregate) is added to the reinforcement mat and the concrete is strongly rammed to tighten the coarse aggregates as in Figure 3a &3b.

After settling there exist an chemical reaction between these two ingredients results in the setting and progressive hardening of the concrete as in Figure 3c. For getting the strongest possible concrete, curing is done for 28 days.



(a) **(b)** **(c)**

Figure 3a &3b Steel and bamboo reinforcement **Figure 3c Steel and bamboo reinforcement slab.**

3. RESULTS AND DISCUSSIONS

The three different specimens are tested in the uniaxial tensile testing machine and the tensile strength values are shown in Figure 4. The 25% of the reinforcement volume had more strength value than the 30% and 40% of reinforcement volume.

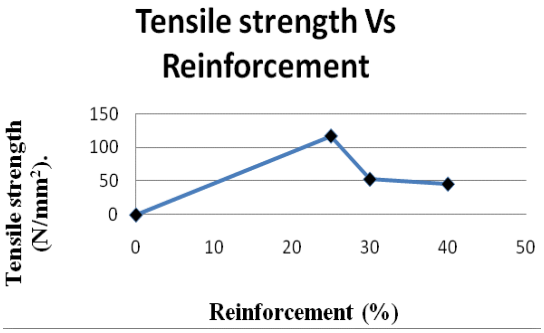


Figure.4. Tensile strength Vs. Reinforcement for different compositions of composites.

Simultaneously the compressive test is made on the steel and bamboo reinforced concrete slabs by using the compressive testing machine. The values of the deflection and load withstanding capacity are found and shown in Figure 5.

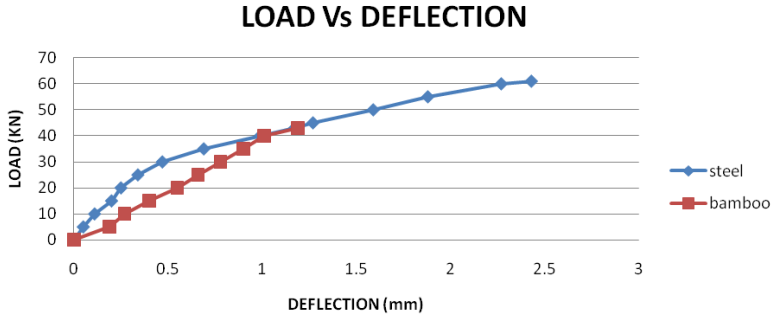


Figure.5. Comparison between load and deflection values for bamboo and steel reinforced slab.

Similarly a Six Concrete cubes were prepared by mixing of cement, sand, and aggregates without using any reinforcements and it is also cured for 28 days to attain the maximum strength. After curing, the specimens were tested in compression testing machine.

4. CONCLUSION

Thus the bamboo can be used as a possible replacement of steel in the modern engineering constructions. The tensile strength of bamboo is relatively high which makes bamboo an attractive alternative to steel in tensile loading applications. The bamboo reinforced concrete slab (43KN) has less load withstanding capacity than the steel reinforced concrete slab (61KN). The bamboo reinforced concrete slab and steel reinforced concrete slab are having high tensile stress than normal concrete without reinforcement. At the same time the deflection of the both slabs are merely equal at 40KN load. So that steel can be replaced with bamboo in minimal loading for structural applications.

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