International Journal of Advance Research and Innovation
Vol. 5(3), Jul-Sept 2017, pp. 34-41
Doi: 10.51976/ijari.531706
www.gla.ac.in/journals/ijari

Article Info
Received: 25 Jan 2017 | Revised Submission: 20 Feb 2017 | Accepted: 28 Feb 2017 | Available Online: 15 Sept 2017

Bamboo Panel in Building Structure

Swapnil Dange and SV Pataskar***

ABSTRACT

Due to terrific growth of population all over India, there is increase in demand for buildings to provide adequate shelter for people. Because of this reason, there is increase in concrete structures and other type of structure. The concrete structures are very heavy as compared to wooden structure. So these concrete structures can be replaced by wooden composites materials and other type of materials. The implementation of new technology will result in waste material being efficiently utilized as sustainable resources for the industry. In this study, bamboo is used as a renewable material along with saw dust and coconut husk as agricultural waste. Bamboo is fast growing and ecologically friendly material for structural applications is being considered as quite appropriate. Bamboo composites panels can provide tailored solution to the eco- housing initiatives at cheaper coasts. In this study the attempt has been made to develop engineered bamboo composite panels for use in housing.

Keywords: *Bamboo; Epoxy Resin; Sawdust; Coconut Husk; Renewable Material.*

1.0 Introduction

In India the rising need of construction industry such as housing, building, infrastructures, and roads in country and require a variety of alternative materials for housing and building components and construction systems. Now a day's escalation of wood consumption in construction industry is very fast. Protection and shelter against three main things such as rain, wind and cold is a very basic need of human beings. From ancient times wood or timber has been the most important material used for this purpose. The building industry directly or indirectly, causing a considerable part of the annual environmental damage. The responsibility is contributed to sustainable development by finding more environmentally being ways of construction and building. One of the directions new material applications are in recycling and reuse, sustainable production of products, or use of renewable resources. Attention has to be given to materials such as vegetable fibers including bamboo, jute, glass, wastes from industry, mining and agricultural products for engineering applications to control environmental degradation and to minimize cost.

1.1 Bamboo

Bamboo is agro-forestry based renewable raw material resource. Bamboo is a grass not a wood and they are growing a very fast as compared to the timber. It is properly treated and the components made by using this treated bamboo may have a responsible life, near about 30-40 years. Bamboo has 8-10 sub families and number of difference species. It has ranging from the type of wood to bamboo herb. Bamboo is used in industrial processing and a high potential production of composites materials for housing and construction of building sector. These materials are cost effective and can be successfully utilized for structural and non-structural part of construction industry.

Bamboo has high tensile strength and weight to strength ratio. It can withstand 3656 kg/cm2 and easily worked upon by simple tools and machines. Bamboo has high strength against forces developed by high velocity winds and earthquakes. Advancements in bamboo technology offer several cost-effective and environment friendly options. Bamboo is a long and well established tradition for being used as a construction industry as a material throughout the world.

**Corresponding Author: Department of Civil Engineering, DYPatil College of Engineering, Pune-411044, Maharashtra. India (E-mail: swapnil.dange2020@gmail.com; pgcivilcm@gmail.com)*
***Department of Civil Engineering, DYPatil College of Engineering, Pune-411044, Maharashtra. India*

The rising global concern, bamboo is a critical resource as it is very efficient in sequestering carbon and helps in reduction of Greenhouse gas emissions.

1.2 Epoxy resin

This resin is a group of synthetic resins which used as an adhesive and to make plastic. Epoxy resin is noted for their usefulness, but cost of this resin is high. Its high cost has limited use but imparts high resistance to chemicals. It has outstanding adhesion; toughness, durability, and this outstanding adhesion have made them valuable as coating materials. The epoxy resin adhesive is heat and chemical resistant. The strength of this adhesive is humiliated at temperature above 350 °F (177 °C).

Epoxy resin is used as an adhesive and gives a hard, chemical resistant and solvent resilient finish. These resins are typically used for timber, boards, concrete, steel and fibers to make them to water, alkali and acids resistant. Epoxy resin coatings are used to put clear and definite appearance for the product based upon the performance necessities. Diglycidyl ethers of bischenol A (Epoxy glue) is obtained from reaction of epichlorohydrin with bisphenol A.Bisphenol A diglycidyl ether is formed from two moles of epichlorohydrin with one mole of bisphenol A. The simplest epoxy is a three-member ring structure such as oxygen atom bonded to two carbon atoms known by the term 'alpha-epoxy' or '1,2-epoxy'. Epoxy resin is available in liquid, solutions, solid, blends and multifunctional forms. These epoxies find wide application in the automotive, construction, heavy engineering, transport, electronics, food, beverage packing, coatings, composites, adhesives, aviation, aerospace and wind energy industries. Epoxies differ from polyester resins in the manner they are cured by a 'hardener' rather than a catalyst. The hardener, often an amine is used to cure the epoxy by an 'addition reaction' where both materials take place in the chemical reaction.

1.3 Saw dust and coconut husk

Saw dust and coconut husk is the waste generated from the timber industry. It is reused in the industries for making of boards, fuel for fire purpose, rope, coach etc. In India, the coconut cultivation area is about 1.6 million ha and 12400 million nuts produced annually [1]. Almost 3.7 million tons of husk is produced annually and dry weight of husk in each nut is 0.3 kg. These waste dusts fulfill the filler material requirement and it gives good properties. Major use of sawdust and coconut husk is for particleboard and as a fuel. The coconut husk is also known as coir. Coconut husk has become a very beneficial material in light of today's environmental and financial concerns. Coir fiber has been recognized as highly durable fiber in all type of matrices, polymers, bitumen, gypsum, cement, mud, fly ash- lime etc. Coconut husk is also used in the production of some popular products such as carpets, rugs, door mats, mattresses, car seat covers, brushes, bristles and flower pots.

1.4 Treatment on bamboo

The treatment on bamboo is to increase the durability of bamboo. It is to protect from insects and fungal attacks. It is necessary to carry out reliable preservation of every bamboo pole. Bamboo and bamboo product are treated with non-chemical treatment or chemical treatment and to improve the durability and performance of bamboo. Increasing the life of bamboo is 20 to 40 years or more than that. Diffusion/ Dipping process is more effective than other type of treatment such as spreading, smoking, leaching etc. Different shape and size of bamboo can be treated by keeping them dip in water borne preservation solution. The solution moves in to the bamboo due to concentration gradient. All bamboo cell sap moves out due to osmatic pressure. This treatment process is very slow and required large number of tanks.

Total time required for this process is from 15 days to 1 month. This treatment is suitable for 50-100 clums in a month’s. Bamboos are immersed in 15 to 20days in Copper Chrome Boron solution for dip diffusion method.

The method of diffusion can be varied by increasing the concentration of preservative to reduce treatment time. Following treatment process is conducted on bamboo:

Chemicals that can be used for treatment on bamboo was Copper Chrome Boron (CCB)

1) Sodium Dichromate = 400 gm. = Rs. 685 (500 gm.)
2) Copper Sulfate = 300 gm. = Rs. 555 (500 gm.)
3) Boric Acid = 150 gm. = Rs. 378 (500 gm.)

All chemicals are dissolved in 10 liter of water by using dip diffusion process. After 8days all bamboos were removed from the chemicals water. All bamboos were dry in shadow region for 15-20 days.

Fig 1: Chemicals Used in Treatment

Fig 2: Mixture of Chemicals and Water

Fig 3: Dipping Process of Bamboo

Fig 4: Drying Process of Bamboo

2.0 Problem Statement

In construction industry the RCC structure is very heavy as compared to live loads on the structure. The concrete slab is designed for the live load and dead load; but these live loads are less as compared to dead loads. Hence to withstand this dead load we have to provide greater sections in RCC structure. Based on this loading consideration, the slabs, beams and columns are designed.

But in these structures the material used is sand, cement and aggregate which is non-renewable and obtained from natural resources. After some years this materials are to decline. Therefore in future there will not be any material available for construction industry. Hence there is need to replace with renewable material such as a steel, wood composites, agricultural wastes, Bamboo etc. Renewable material gives the more green effect to buildings. Renewable materials can be produced or reused again and again, but concrete is not used again and again. By using renewable and lightweight materials for slab and wall, the dead load of slab and wall can be reduced. Thus the structure can be made light weight. Hence there is need to find out the light weight alternatives for RCC slab and brick wall.

3.0 Objective of Study

Followings are the objectives of proposed work:

1. To identify, study and selection of Renewable Materials and Agricultural waste material for construction of floor and wall.
2. To prepare the bamboo and wooden composites panel for wall and floor.

3. To test the bamboo and wooden composites panel.
4. Cost analysis of designed structure

4.0 Preparation of Panel

Plywood sheet is available in 8X4 feet size and it is required to support panels and to make smooth surface. In this study, 3 mm plywood sheet is used. The details about the panel such as bamboo panel's size, bamboo size, deodar wood frame size, thickness of panel, thickness of deodar wood, distance between of bamboos etc. are given in the figure 2 and 3.

Fig 5: Design of Panels Size 1.5 X 1 m

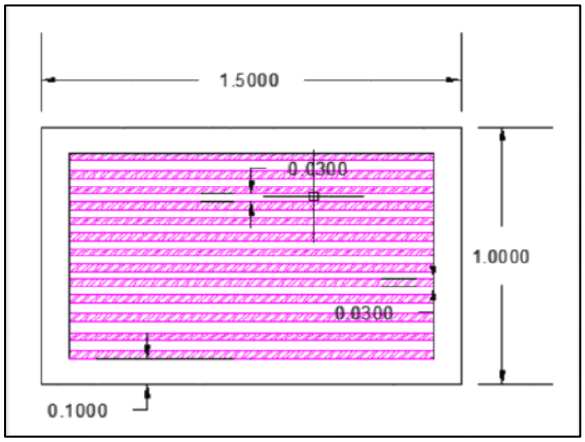
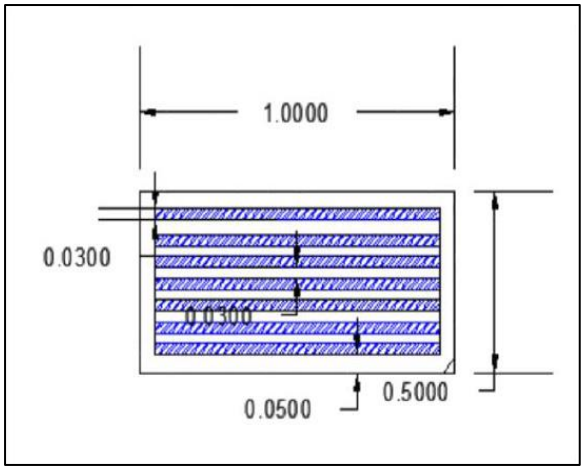
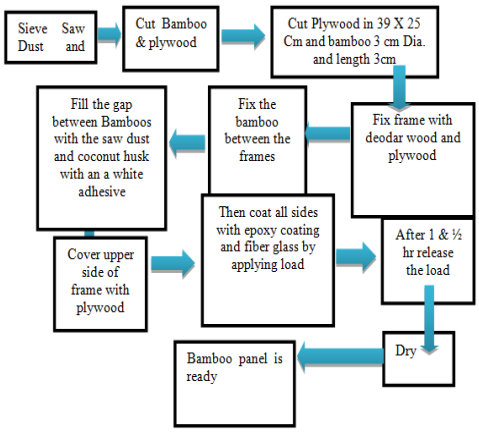


Fig 6: Design of Panel Size 1 X 0.5 m



Bamboo Panel making details is given in flow chart (fig.7) and step by step procedure is shown in figure 8.

Fig 7: Flow chart of Panel Making Process



The images given below are gives the information about a bamboo panel's preparation. All images are arranged in the step by step sequence as the panel making procedure. All steps are discussed as below:

Steps1 – (A) – Take 3 cm diameter bamboo. Clear all the nodes and maintain 3cm diameter of whole bamboo. Total length of bamboo is taken as per requirement of size of panels. In this paper, length of bamboo chosen is 1m.

Step 2 – (B) – After clearing all the bamboo, cut the plywood and deodar wood as per requirement. Size of board or panel is available as per requirement of customer and site requirement. The size of plywood is 1.2 X 0.5 m and deodar wood strips are 6 cm wide and 3 cm thick and length is same as plywood. Fix this deodar wood strips and plywood with the help of ¾ inch nails.

Step 3 – (C) – After fixing the whole body of panel, fix 5-6 bamboo in between the deodar wood strips with the help of nails and epoxy resin. All bamboos are placed in proper manner and maintain the 3 cm thickness of panel.

Step 4 – (D) – After 10-15 minutes the epoxy resin is dried and all bamboos are fixed. Then prepare a mixture of coconut husk and saw dust with a white adhesive. Saw dust and husk is combined with white adhesive and it is compacted properly by applying specific load.

Step 5 – (E) – After compacting the mixtures of saw dust and coconut husk in between the bamboo, apply an epoxy resin to the upper side of the bamboo and dust and upper plywood, so as to fix them in proper manner.

Step 6 – (F) – Apply epoxy resin on upper side of bamboo. Then upper side of panels is closed with same size of plywood with the help of the nails.

Step 7 – (G), (H), (I), (J), (K),(L),(M) – Check all sides of panels are properly fixed. Check all sides of panels are properly closed and there is no any defect in panel. Then apply the fibers glass mat on it. Fiber glass mat gives toughness to the panels and protect it from fire. Apply a glass fiber on one side of panel and then apply epoxy resin on glass fiber. In order to obtain smooth surface finish, plastic cover is applied to upper side of glass fibers. Then by using finishing tools air voids are removed and upper sides of panel is made smooth. The same process is repeated for second side and edges of the panel.

Step 8 – (N) – After drying of panel, fibers are cleaned and sides of panels are finished with the help of finishing machine.

Fig 8(a): Preparation of Bamboo Panel

Fig 8(b): Preparation of Bamboo Panel

Fig 8(c): Preparation of Bamboo Panel

Fig 8(d): Preparation of Bamboo Panel

Fig 8(e): Preparation of Bamboo Panel

Fig 8(f): Preparation of Bamboo Panel

Fig 8(g): Preparation of Bamboo Panel

Fig8 (h): Preparation of Bamboo Panel

Fig 8(i): Preparation of Bamboo Panel

Fig 8(j): Preparation of Bamboo Panel

Fig 8(k): Preparation of Bamboo Panel

Fig 8(l): Preparation of Bamboo Panel

Fig 8(m): Preparation of Bamboo Panel

Fig 8(n): Preparation of Bamboo Panel

5.0 Application of Bamboo Panel

The applications of bamboo composite panels in civil construction industry are include:

1) Light weight panels for high rise building and bunglows for panelling purpose.
2) Partition walls and panels of various dimensions in place.
3) Panel Doors and Flush Doors.
4) All type of insulations works.
5) All type of Furniture works.
6) Ceiling and Floors purpose.
7) Internal and external purpose for precast domestic and industrial panels.
8) Efficient site construction.
9) Contractor familarities.
10) Ideal as a timber subfloor base under decorative timber flooring.

5.1 .Benefits of panels

There are too much of benefits of bamboo composite panels and these are includes

- Reduces the dead weight of the structure from 1/4- 1/3 weight of normal concrete.
- It can be factory-made to particular specification of density.
- It can be nailed, drilled and planed.
- It can be available in excellent heat insulation and sound insulation.
- It is water resistant, moisture resistant and fire resistant panel.
- Easily installed in new or existing building.

5.2 Cost of bamboo panel

The costs of 1 m2 bamboo composite panel and list of materials which is used with their market cost:

Table 1: Cost of 1m^2 Panel

Material	Bamboo Panel
Bamboo(Rs.20/m)	Rs.280
Plywood (3mm)(Rs.13/sq.ft.)	Rs.279.76
Saw Dust(Rs.125/Bag)	Rs.7.5
Adhesive(Rs.100/ litter)	Rs.125
Fiber Glass(Rs.150/kg)	Rs.24.75
Deodar Wood(Rs.31/kg)	Rs.66
Total	Rs.935

6.0 Conclusions

Bamboo, coconut husk and saw dust are renewable material selected for the panel preparation, because it is available easily in local area and cost is very cheap. All material is green construction material.

Use of bamboo panel in wall, floor, slab reduce the dead load of structure so that cost will also reduce automatically as bamboo is cheap as compare to steel, brick, concrete and other construction material.

Acknowledgment

The This research would have not been completed without the help of my Guide Prof.S.V.Pataskar and M/s Malhotra Developers, Pune for working me out on their Site. I would like to thank my institute D.Y Patil College of Engineering, Akurdi Pune.

References

[1] CN Pandey, DSujatha. Crop Residues, the alternate raw material of tomorrow for the preparation of composite board, Indian Plywood Training and Research Institute, Bangalore

[2] P Chaowana. Bamboo: An Alternative Raw Material for Wood and Wood-Based

Composites, Journal of Materials Science Research, 2(2), 2013.

[3] H Banga, VK Singh, SK Choudhary. Fabrication and Study of Mechanical Properties of Bamboo Fiber Reinforced Bio-Composites, Innovative Systems Design and Engineering, 6, 2015

[4] National Mission on Bamboo Applications, Training manual preservation of bamboo, Technology Information, Forecasting, and Assessment Council (TIFAC) 2006.

[5] AS/NZS 1859:2005- Reconstituted Wood-Based Panels— Specifications.