

NOVEL APPLICATION OF BAMBOO AS A CONSTRUCTION MATERIAL (plywood)

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Abstract— Demand for efficient infrastructure is increasing and thus the demand for construction material increase. As the material cost is highly increased in order to have economical , sustainable material new search of material is undergone several studies have proved bamboo as an compatible construction material .It is of predominant importance in engineering. Bamboo is characterised as renewable, perishable and cost efficient resource. The renewable property of bamboo has forced us to use this in construction fields from hundreds of years They're extraordinarily versatile resource with multi-purpose usage. It has shown it's vast contribution in architecture too. From making a home full of aesthetic to making plywood's, bamboo is used everywhere. It can be used as a replacement for scarcity of timber, thus making wood as cost friendly.

Index Terms—Alternative material, Bamboo, Construction materials, eco-friendly material, Flattened bamboo, plywood, renewable resource, surrounding friendly, sustainable.

1 INTRODUCTION

THE rapid demand for wood and wood based material is rising day by day. While the availability of wood is decreasing day by day due to the global biomass demands. Thus the alternative raw material in place of wood has become the need of the hour. The alternative raw material should be inexpensive, fast growing easily available and having both mechanical as well as physical properties like that of wood. Bamboo can be used as one such alternative. Bamboo being one of the most ancient building material used by mankind from decades. The bamboo have been used in construction for ceiling, flooring, windows, doors, fences, roofs, trusses, rafters etc. [1]

Bamboo is the World's one of the fastest growing species of Woody grass. It grows almost 7.5 to 40 CM a day. The Japanese bamboo is having a world record of growing 1.2m in 24 hours. Bamboo grows 3 times faster than most of the species. Commercially used bamboo matures four or five years' time after that many harvest are possible every second year, for up to 120 years in some species and indefinitely in others. Bamboo is often planted near the banks of rivers in order to hold the soil firmly, thus preventing any

sort of erosion. Thus bamboo has proven itself to be the most efficient fir replacement of wood as its material is easily available, fastest growing and is eco-friendly. It is very cost effective and easy to work. It can easily bend and can be given desired shapes. It's is very elastic which enables it to sustain in the areas prone to earthquakes. It's locally available and thus carries the local tradition and vernacular architecture of the place. [2]

1.2 HISTORY OF BAMBOO

Bambusoideae are a lineage of Perennial forest grasses found in almost every continent except Europe and Antarctica. The bambusoideae consists of about 1450 species of bamboo. Woody and herbaceous bamboo are the two morphologically distinct habits of bambusoideae. Bamboo have always been an integral part of economy in South Asia and East Asia. Giant bamboo are the biggest members of the family poaceae. [3]

2 METHODOLOGY

Laminated bamboo plywood is made from the flattened rectangular pieces that are extracted from bamboo. These pieces or strips are then glued together either horizontally or vertically. Less swelling or shrinkage is seen, than the solid wood panels because of individual strips in laminated bamboo.

At the time of harvesting good and efficient bamboos must be selected of approximate diameter of 8 to 10cm which are cut into length of 250cm. Once harvesting is done there comes a challenge to tackle that is the bamboo preservation. There are some methods and technique by which we can treat bamboo and increase their life.



Fig.2 Laminated Bamboo [5]

Source (bamboo blog by stephane)

2.1 Traditional or non chemical preservation of bamboo

In this method bamboo is soaked in water for a long period of time. This method is mostly carried out by rural communities. The bamboo is soaked in running and still water. The soaking process should not exceed more than 30 days. This method reduces the starch content in bamboo that will be used in construction material. When the starch content is reduced the bamboo will not be attacked by the pests. Further the decrease in starch content Increases the strength of the bamboo. The process is considered to be complete when colour changes to pale and has acidic odour. This traditional method results in great bamboo strength. [4]

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2.2 Modern or chemical preservation of bamboo

There is one very easy and economical way to preserve bamboo and that is by gravity method. Range for bamboo preservation becomes unlimited due to this simple method. Chemical methods are usually expensive, but the results are better and offers more protection. Presently the use of chemical fir preservation of bamboo is mostly used, as they offer more termite resistance and offer excellent durability. The obstacles that chemical method faces is that it is harmful for the health and environment. The concentration of preservation solution should be carefully estimate in order to achieve success. Some of the popular chemical methods include Butt treatment, the open tank method, the bouche-rie method and fumigation with methyl bromide compounds. In India, Taiwan and Japan chemical methods are largely used.

2.3 Procedure

After harvesting and treatment process we have to split the bamboo poles. The bamboo poles are first placed in special kind of machine (star shaped) which converts them into bamboo slates. The bamboo slates are very irregular in shape and structure. We have to eliminate the green Party and inner nodes. For that 22x6 dimension is planned. After that bamboo are plain pressed and side pressed in presence of a raw glue. In order to make thicker panels several layers are glued together. After that a band saw is used to convert the plywood into required dimensions. Sanding and quality control are the final processes. [5]

The most of the process of laminated bamboo and strand woven bamboo are almost same except one thing that the strips are not glued horizontally and vertically. Instead raw bamboo strands are compressed under pressure to form a new composite material. The processed strips are directly crushed into the rough fibrous bamboo strands. The bamboo strand are coated with glue before putting them in the press. After that the bamboo strands are kept under a pressure of 2,500 tons where the bamboo strands are compressed. They are available at a maximum thickness of 20mm. Otherwise they will become very heavy. Smaller boxes of 10_30 cm wide are sawn from 30_40mm thick panels. After that they are cut into the desirable sizes. These

bamboo planks can also be processed into the sidings, deck-ing's, flooring etc. The strand woven bamboo is considered as the easiest process. [5]

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2.4 literature review

SR.NO	Research paper title/ reference	Year	Outcomes
1	Designing and building with bamboo Jules J.A Janssen	2000	<p>1.The two methods for preservation are shown. Traditional preservation done by transpiration process and chemical preservation done by various methods like dip diffusion and modified boucherie process.</p> <p>2.It is shown that bamboo can be used as a fibre reinforced cement mortar, bamboo reinforcing in concrete, bamboo for framework and soil reinforcement.</p>
2	Bamboo: As an alternative raw material for wood and wood based composites Pannipa chaowana	2013	<p>1. It is shown that the bamboo has straight grain, beautiful color, high strength, toughness and excellent abrasion resistance. Wood composites and bamboo composites consist of similar properties.</p> <p>2.it is easy to process. It will be a very competitive and important forest based product in future.</p>
3	Bamboo as a building material P. Sharma et al	2014	<p>1. It is shown that the bamboo is light, strong, versatile, environment friendly, self-renewing, fast growing, high productive and accessible to poor.</p> <p>2. It guides us towards the fact that bamboo require preservation and catches fire easily. It is shaped by nature and can be easily attacked by pests.</p>
4.	Journal of Civil Engineering and Environmental Technology Krishi Sanskriti Publications	2014	<p>1. It can easily bend and can be given desired shapes. It's is very elastic which enables it to sustain in the areas prone to earthquakes.</p> <p>2. It is locally available and thus carries the local tradition and vernacular architecture of the place.</p>
5	Engineered bamboo for structural application Bhavana Sharma et al.	2015	<p>1. It is shown that engineered bamboo products have properties that are comparable to or surpass that of timber and timber based products</p> <p>2. bamboo Scrimber and laminated bamboo are heavily processed before testing.</p>

6	How bamboo lumber is made International Journal of Scientific & Engineering Research Volume 12, Issue 11, November 2021 ISSN 2229-5049 Stephane	2016	1. It shows that most of the process of laminated bamboo and strand woven bamboo are almost same except one thing that the strips are not glued horizontally and vertically. Instead raw bamboo strands are compressed under pressure to form a new composite material.
7	Bamboo as a construction material Nitin kumar et al	2017	1. It is shown that bamboo has a greater tensile strength than compressive strength. It has a higher elastic modulus and has great fire resistance. But the shrinkage factor needs to be checked. 2. It can be used as a wood substitute in Domestic houses and small building. It is economical due to its fast growing ability.
8	Development of bamboo Scrimber:a literature review Huang et al.	2019	1. It is shown that Bamboo is the World's one of the fastest growing species of Woody grass. It grows almost 7.5 to 40 CM a day. Further, Bamboo grows 3 times faster than most of the species
9	Novel advanced composite bamboo structural member with Bio-based and synthetic matrices for sustainable construction Amir mofidi et al	2020	1. The proposed bamboo-composite systems, except for that of SCB-GRT-H specimen, can enhance the compressive strength of columns made up of bamboo when compared to the non-composite control specimen. 2. The full culm bamboo and goutcomposite specimen reached 48.4% gain, whereas, the split culm bamboo and gout composites specimen failed to provide any gain in compressive capacity due to improper composted action between split bamboo and grout.
10	Overview of bamboo preservation methods for hot and humid climate Athiyyah Harivi Putri et al.	2020	1. It is seen that in terms of productivity, the chemical method is more effective because it is done very quickly, so it can preserve bamboo in large quantities. 2. However, in terms of durability, the traditional process results in more durable bamboo. Traditional methods are considered to be more suitable for the bamboo building construction in hot and humid region.

3 WHY BAMBOO PLYWOOD IS BETTER THAN HARDWOODS?

Hardwoods have proven to be very efficient and of great demand for construction from centuries. But due to increase in demand the resources are reaching at the verge of extinction. Our forest resources are depleting due to the excess demand of wood. On the other hand bamboo production is increasing. So it's the demand of the time to use the alternative bamboo resources as wood. Bamboo has proven itself alike as wood. It's even better than the hardwood because of the following reasons;

- Definitely sustainable : Designers are being suggested to use bamboo ply as a new alternative instead of hardwood timber, instead minimising the destruction of forests .Unlike traditional hardwood, every year bamboo can be harvested without destroying the plantation. Bamboo stems can sprout new shoots during the next rains. Bamboo can grow to its full maturity in four to six years while it takes a tree decades or even more.[6]
- Strong and enduring: bamboo plywood is stronger than most of the hardwoods .Bamboo ply is stronger and harder wearing than most hardwoods. The tensile strength of bamboo is 28,000 per square inch versus 23,000 for steel, and the material is 25 per cent than Red Oak and 12 per cent harder than North American maple. Bamboo plywood is made up of layers of bamboo stripes, kiln dried, sanded and then laminated, thus making them stable and prevents warping. [6]
- Design flexibility: bamboo plywood can be cut, sanded, nailed, screwed and plugged using conventional woodworking equipment and also offers excellent dimensional stability.[6]

3.1 ADVANTAGES OF BAMBOO

- Bamboo is a fast growing renewable resource, not like other woods which take years to grow up. If we

cut the bamboo and use it for construction purpose, it will grow again. Thus maintaining a balance in nature. [7]

- Using bamboo as a construction material may also generate income sourced for the local people through cultivation, management, Pre-processing and processing stages. Particularly in developing countries it will empower the community by generating income sources. [7]
- Because of unique orientation of bamboo wood, it is suitable for all types of architectural orientation. Bamboo plywood can be used to make counter tops, furniture, cupboard, Almirah, penelling etc. Bamboo can do anything which hardwoods can do. [8]
- Bamboo plywood is an emission free process that is eco-friendly and doesn't produce any harmful waste that can harm environment. Many bamboo plywood making factories are active in various regions and they are producing a great quality and cost friendly bamboo plywood sheets. [8]

3.2 DISADVANTAGES OF BAMBOO

- Bamboo materials are not satisfactory for exterior home improvements. Bamboo plywood cannot be treated chemically to prevent it from decorations due to external weather. [8]
- Bamboo offers great resistance towards water. But if it is immersed in water for larger time it may deteriorate. So if bamboo plywood comes in contact with water we have to wipe it off. [8]
- Bamboo plywood is three times dent resistant than hardwoods. But it is not scratch resistant. [8]
- Bamboo plywood is prone to warping like other woods, if stored in very low or very high humid area. Uneven moisture content can cause deformity in the sheets. [8]

4 CONCLUSION

Bamboo is an excellent alternative to tropical hardwood. Due to its excellent durability and its natural artistic feel, it can go with any home design. Its fascinating properties makes it an eco-friendly and sustainable choice for a wide variety of home projects. By choosing bamboo, you are taking an initiative towards the destruction of native forests.

However, like any other hardwood material, bamboo is also prone to destruction from harsh temperatures and humid climate when not maintained correctly. For this reasons, bamboos are not suitable for external use.

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