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Bamboo as a Construction Material

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Abstract—*The world timber demand is increasing at a rapid rate but the timber supply is depleting. It's been found through research that bamboo can suitably replace timber and other materials in construction and other works. Industrially treated bamboo has shown great potential for production of composite materials and components which are cost-effective and can be successfully utilized for structural and non-structural applications in construction. Bamboo is one of the oldest traditional building materials used by mankind.*

With the advancement of science and technology and the tight supply of timber, new methods are needed for the processing of bamboo to make it more durable and more usable in terms of building materials. Studies have been carried out on the basic properties and on processing of bamboo into various kinds of composite products. Bamboo has several unique advantages like ability to grow fast with a high yield and also it matures quickly. Additionally bamboo can be grown abundantly and that too at a lower cost which makes it more economical.

1. INTRODUCTION

Building with bamboo looks back on an ancient tradition in the regions in which plant grows in abundance, such as South America, Africa and, in particular, in South-East Asia. Bamboo is one of the oldest construction materials.

Fig. 1: Bamboo

Characterised by the type of rhizome and the formation of upright canes there are three main groups of bamboo. The first group is called monopodial bamboos. They form long and thin extensions of the rhizome whose buds produce single shoots are regular intervals. The sympodial bamboos constitute the second group. They have short, thick rootstocks the tips of which produce the canes. The third group is called climbing bamboos. They can grow very irregularly and may form impenetrable thickets.

1.1 Growth

The growth pattern of the bamboos is a singular combination of grass, leaf-bearing tree and palm.The following characteristics distinguish bamboos from grasses: the longevity of their canes, their branching and the lignifications. Like leaf bearing trees they increase their crown every year by throwing out new branches and also shed their leaves each year. The growth pattern of the trunk is similar to that of the palm tree. Emerging with its definitive circumference from the soil without increasing in diameter later. The species "Guadua angustifolia" will reach length of up to 20 - 25 m with a diameter of 12 cm.

1.2 Root

Bamboo has durable rootstocks, the rhizomes. After a seedling has produced the first rhizome, the differentiated rhizome system will begin to develop.According to the type of branching of the rhizomes the main group of the bamboos is called monopodial, whereas the other group is called sympodial.

Fig. 2 Bamboo Roots

1.3 Life Span

The canes die and fall to the ground only a few weeks after the production of flowers and fruits. Frequently their rhizomes are exhausted and also die. With the large species the life span is determined by the flowering period which can be up to 100 years. In the latter case the flowering period and the life span are not equal because the plant can flower frequently without dying.

2. OBJECTIVE

1. To check and see whether Bamboo can be used as a suitable material for construction.
2. To minimize the cost of construction works.
3. To enhance the aesthetics of structures.
4. For welfare of the society, particularly of the economically weaker section.

3. PROPERTIES OF BAMBOO

3.1Tensile strength:

The fibres of the bamboo run axial. In the outer zone are highly elastic vascular bundles that have a high tensile strength. The tensile strength of these fibres is higher than that of steel, but it is not possible to construct connections that can transfer these tensile strengths.

3.2Shrinking

Bamboo shrinks more than wood when it loses water. The canes can tear apart at the nodes. Bamboo shrinks in the cross section ca. 10-16 %, in the wall thickness ca. 15-17 %.

3.3Fire resistance

The fire resistance is very good because of the high content of silicate acid. Filled up with water, it can withstand a temperature of 400° C while the water boils inside.

3.4Elasticity

The enormous elasticity of bamboo makes it to be a very good building material for earth-quakeen dangered areas. Another advantage of bamboo is its low weight. It can be transported and worked easily, the use of cranes is mostly unnecessary.

3.5Advantages of using bamboo

1. It is economical and helps achieve cost effective construction.
2. Bamboo is a fast growing species and it is a renewable resource which can be cultivated in most types of soil.
3. The designs of the components being simple, there is no need of highly skilled labour.
4. The dependency on the natural forests for wood will be reduced thus contributing to the protection of the environment.

4. WORKING OF BAMBOO

Bamboo can be worked with the simplest tools which must be especially sharp because of the highly silicified outer zone. Tool wear is considerably high. The recommendable methods are:

4.1 Splitting

Splitting is very easy as long as you work along the cane axis. The cane is split in halves and quarters and the driven apart by a wedge. It can also be split with a knife frame into four or eight segments.

4.2 Cutting

Cutting with a machete-type or knife used for Cutting, Sawing and Scorch drilling.

4.3 Shaping

Bamboo which grows in a box gets a square shape. So it can be better used for connections.

4.4 Bending

Freshly cut, bamboo can be bent and will keep this shape after drying. When heated above 150° C, bamboo keeps its shape after it goes cold.

5. TREATMENT OF THE SURFACE OF BAMBOO”

The information about bleaching and dyeing are determined for small parts for kite-constructions. Bleaching and dyeing possibly can change the structure of the bamboo that far, it can’t support enough weight. Nevertheless these methods should be introduced.

5.1 Bleaching

Bleaching in hydrogen peroxide removes traces of resin or wax. If it stays in it too long, the bamboo will get perished.

5.2 Dyeing

Every country has developed its own traditional method of Dyeing.

5.2.1 Principle of Dyeing:

1. Remove the wax, otherwise the colour can’t penetrate into the bamboo.
2. Bleach before dyeing, so the colour will become more regular.
3. After dyeing, fix the colour in a solution of vinegar.

5.3 Other Methods

The surface is to be peeled off, hydrochloric acid is put on the bamboo and the canes are put in an oven. The canes get a brown colour. Treating the canes with copper sulphate will give a green colour to the bamboo and protects it from mould. These methods only dye the surface of the bamboo. To get a through and through dyeing, the bamboo can be Carbonised. The bamboo is put into a boiler and is incubated with a pressure of 5 kg/cm³ and a temperature of 150° C for 20-30 min. After that, the bamboo will be brown through and through.

6. APPLICATIONS OF BAMBOO

Bamboo material offers a surprisingly large number of applications and uses. Bamboo as a building material in the bamboo architecture is used for several constructions. In the following some of these construction will be represent.

6.1 Bamboo Houses

Bamboo houses are without exception skeletal buildings having raised floors with main posts which are anchored in the ground.The structural safety of the skeletal structure is almost exclusively provided by the posts anchored in the ground. The only vertical and horizontal forces acting on the structure are wind pressure, roof moisture, live loads and dead weight.

Fig. 3: Bamboo house

6.2 Bamboo Doors and Windows:

Bamboo frames can replace timber frames appropriate to function. Bamboo mat shutters fixed to bamboo frame or a panel of bamboo board fixed to the frame which is hinged to the wall can be used as door. Small framed openings hinged to the top in the wall can serve as windows.

Fig. 4: Bamboo doors and windows

6.3 Roofing

The simplest roof covering is formed by bamboo shingles which are as long as the rafters. To produce the shingles the bamboo canes are halved along their length and the diaphragms are removed. They are threaded to the ridge and placed in Roman tile fashion. These shingles are fixed at the eaves. They are held in position by their own weight.

Fig. 5 Bamboo Roofing

6.4 Scaffoldings:

Because of the favourable relationship between load-bearing capacity and weight, bamboo can be used for the construction of save scaffoldings even for very tall buildings.

Fig. 6 Bamboo canes used for scaffoldings

6.5 Bamboo Flooring:

Bamboo can be used as flooring material due to its better wear and tear resistance and its resilience properties. Whole culms act as frame work and the floor covering is done using split bamboo, bamboo boards, mats etc.

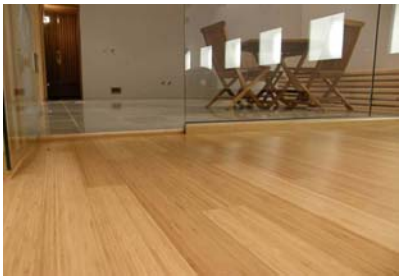

Fig. 7 Bamboo Flooring

6.6 Footbridges and Bridges

Footbridges and bridges are also constructed from bamboo material. Since bamboo is much more elastic than solid timber, its use requires particular constructional measures which limit vibration, bending and twisting. Footbridges and bridges are structures which are exposed to the weather, if indeed they are covered. For this reason their life span is only one third of that of house structures.

6.6.1 Footbridge without surface

Tied battens hold the poles together and act as a load distributor so that the load on a single pole is transferred to its neighbour. The ends of the poles are pinned to the ground. They are secured against turning and displacing.

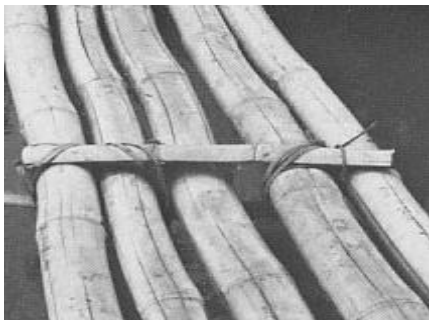

Fig. 8 Footbridge without surface

6.6.2 Footbridge with surface of woven batten:

The layer of poles has differing spacing. The woven battens provide rigidity and distribute the load. Piles serve as intermediate supports and also as posts for the handrail.

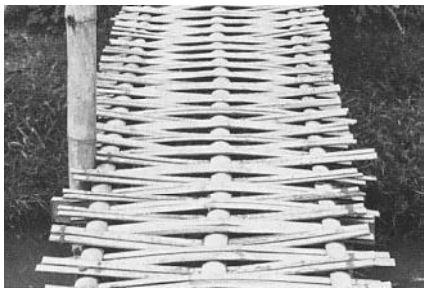

Fig. 9 Footbridge with surface

6.6.3 Footbridge of cane bundle with tied rail:

In this example a bundle of five bamboo poles forms the load-bearing beam. The lashing consists of strips of bamboo bark. The posts are tied diagonally between the beams and hold these in place. The ends of the handrails are supported by vertical posts.

Fig. 10 Footbridge with tied rail

6.6.4 Bamboo bridge with intermediate posts in the river bed

When using many piles, the spanes are usually kept below 2 m. The piles or posts form bundles of two or three posts of which only one continues above the bridge platform to carry the handrail. Longitudinally and transversally they are stiffened by diagonal braces. The bridge floor is covered with woven battens which are held on the floor joists by bars located in the edges. Lateral sliding of this covering is prevented by the bridge posts.

Fig. 11: Bamboo bridge with intermediate posts in the river bed

7. CONCLUSION

The world timber demand is increasing at a rapid rate but the timber supply is depleting. It's been found through research that bamboo can suitably replace timber and other materials in construction and other works. Industrially treated bamboo has shown great potential for production of composite materials and components which are cost-effective and can be successfully utilized for structural and non-structural applications in construction. Bamboo is one of the oldest traditional building materials used by mankind.

The bamboo culm, or stem, has been made into an extended diversity of products ranging from domestic household products to industrial applications. Examples of bamboo products are food containers, handicrafts, toys, furniture, flooring, pulp and paper, boats, charcoal, musical instruments and weapons. Bamboo is quite common for bridges, scaffolding and housing, but it is usually used as a temporary

exterior structural material. In many overly populated regions of the tropics, certain bamboos supply the one suitable material that is sufficiently cheap and plentiful to meet the extensive need for economical housing. It has been used in bicycles, windmills, scales etc. Its uses are broad and plentiful.

With the advancement of science and technology and the tight supply of timber, new methods are needed for the processing of bamboo to make it more durable and more usable in terms of building materials. Studies have been carried out on the basic properties and on processing of bamboo into various kinds of composite products. Bamboo has several unique advantages like ability to grow fast with a high yield and also it matures quickly. Additionally bamboo can be grown abundantly and that too at a lower cost which makes it more economical.

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