BAMBOO AS A CONSTRUCTION MATERIAL

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ABSTRACT

Bamboo is one of the oldest traditional building materials used by mankind. They are the largest members of the grass family and are the fastest-growing in the world. Bamboo is a renewable and versatile resource, characterized by high strength and low weight, and is easily worked using simple tools. Bamboo building construction is characterized by a structural frame approach similar to that applied in traditional timber frame design and construction. Housing is one of the priority items and sensing the current shortage of the dwelling units, the present administrative leaders around the world find tough to hit upon a solution for. Apart from the other substances already in practice, bamboo appears to be the most promising material. Bamboo building construction is characterized by a structural frame approach similar to that applied in traditional timber frame design and construction. In this case, the floor, the wall, the roof elements are all interconnected and often one dependent on the other for overall stability. The use of bamboo for foundation is rather restricted. This is mainly due to the fact that like timber when in contact with damp ground, they deteriorate and decay very quickly unless treated with some very effective preservatives. The most extensive use of bamboo in construction is for the walls and partitions. The major elements, the posts and beams, generally constitute part or structural framework. The roof offers protection against extremes of weather including rain, sun and wind, and to provide shelter, clear and usable space beneath the canopy. Above all it must be strong enough to resist the considerable forces generated by wind and roof coverings. In this respect, bamboo is ideal as a roofing material- it is strong, resilient and light weighted. Bamboo will continue to play an important part in the development of enterprises and the transformation of rural environments.

INTRODUCTION

Bamboo has a long and well-established tradition as a building material throughout the world's tropical and subtropical regions. It is widely used for many forms of construction, in particular for housing in rural areas. It is estimated that there are 1200species growing in about 14.5 million hectares area. Most of them grow in Asia, Africa and Latin America. It grows approximately 7.5 to 40cm a day, with world record being1.2m in 24 hours in Japan. Commercially important species of bamboo usually mature in four or five years time, after which multiple harvests are possible every second year, for up to 120 years in some species and indefinitely in others. It has been used successfully to rehabilitate

soil ravage by brick making in India, and abandoned in Malaysia. Aim of the research is to study how bamboo can affect the environment and the types of bamboo and to study the different construction techniques. Objective of my study is to study the nature of the bamboo and to observe how bamboo can resist different weather conditions. The research will consist of studying bamboo as a construction material. Methods of using and protecting the material, Bamboo use as an environmental material in the future. My study will deal with the construction methods of different component of the building, Bamboo for domestic housing, Details of bamboo as construction material

GENERAL USES

- Soil stabilization, wind break, urban waste water treatment and reduction of nitrates contamination
- Creating a fire line in traditional forests-due to the high content of silica.
- Removing atmospheric carbon-bamboo can capture 17 metric tons of carbon per hectare per year, i.e. effectively than any other species.
- The shoots are edible.
- Building and construction.
- Small scale and cottage industries, for handicrafts and other products.
- New generation products as wood substitutes
- Industrial products
- Transportation industry- truck bodies, railway carriages etc.
- Boards and furniture
- Medicine
- Paper and pulp industry
- Long time source of biomass for industry

Fuel source- capable of generating 1000-6000 cal/g- for households and small industries is an age-old, continuing practice.

BAMBOO HOUSING

The majority of bamboo construction relates to the rural community needs in developing countries. As such domestic housing predominates and in accordance with their rural origins, these buildings are often simple in design and construction a living tradition of local skills and methods. Other common types of construction include farm and school building s and bridges. Further applications of bamboo relevant to construction include its use as scaffolding, water piping and as shuttering and reinforcement for concrete.

Fig. 1 Bamboo Housing

DOMESTIC HOUSING AND SMALL BUILDINGS

There is a long-standing tradition of bamboo construction, dating back to many hundreds of years. Different cultures have found in this material an economical system of building, offering sound yet light and easily replaceable forms of shelter. Activities and tools are often simple, straightforward, accessible even to the young and unskilled. Despite human exploitation and unfavourable treatment, trees maintain it's contributively role towards the dwelling of mankind. Man has for centuries enjoyed the benefits of the free gift of nature. Housing is one of the priority items and sensing the current shortage of the dwelling units, the present administrative leaders around the world find tough to hit upon a solution for. Bamboo building construction is characterized by a structural frame approach similar to that applied in traditional timber frame design and construction. Bamboo based materials are widely used too. In its natural condition as solid culms, halved culms or as longitudinally split strips, bamboo has been used in almost all parts of house construction except for the fireplace and the chimneys. These are described in detail below:

1. Foundation

The use of bamboo for foundation is rather restricted. This is mainly due to the fact that like timber when in contact with damp ground, they deteriorate and decay very quickly unless treated with some very effective preservatives. However, in spite of their short life considerable use of bamboos is made as foundation or supporting posts in case of houses built on raised platforms. The types of bamboo foundations identified are:

a) Bamboo in direct ground contact: Bamboo is placed either on the surface or buried. For strength and stability, large diameter and thick walled sections of bamboo with closely spaced nodes should be used. Where these are not available, smaller sections can be tied together. It can decay within six months to

two years, and hence preservative treatment is recommended.

b) Bamboo on rock or preformed concrete footings: where bamboo is being used for bearings, it should be placed out of ground contact on footings of either rock or preformed concrete. The largest and stiffest sections of bamboo should be used.

c) Composite bamboo/concrete columns: a concrete extension is given to a bamboo post using a plastic tube of the same diameter. The result is a bamboo post with an integral durable foundation.

d) Bamboo piles: it is used to stabilize soft soils and reduce building settlement. The treated split bamboo piles were filled with coconut coir strands wrapped with jute. The sections were then tied with wire. After installation of the piles the area was covered with a sandy material.

2. Flooring

The floors may be at ground level, and therefore consists only of compacted earth, with or without a covering of bamboo matting. The preferred solution is to raise the floor above the ground creating a stilt type of construction. This improves comfort and hygiene and can provide a covered storage area below the floor. The surface of earth floor is sometimes made more stable by paving it with crude bamboo boards made by opening and flattening whole culms. The various types used are:

a) Small bamboo culms: they are directly tied and nailed together.

b) Split bamboo: culms are split along their length into strips, several centimetres wide.

c) Flattened bamboo: formed by splitting green bamboo culms removing the diaphragms, then rolling and flattening them. The resulting board is laid across the joists and fixed by nailing or tying. They are screened with cement mortar for reasons of hygiene and comfort as they are uneven and difficult to clean.

d) Bamboo mats: thin strips varying in size from 5-6mm or 10-15mm and thickness of 0.6-1.2mm. These slivers are then woven into mats of different sizes according to the available hot-press plates and user's demands. After drying the mats to 6-10% moisture content, sufficient glue is applied to ensure enough bonding between the overlapped areas. In construction using bamboo mats, phenol resins are employed.

e) Bamboo plastic composites: it is an innovative technology in which bamboo fibre is the raw material and compounded with plastic as the core material of the flooring. This has higher water resistance and dimensional stability properties than those of normal floorings.

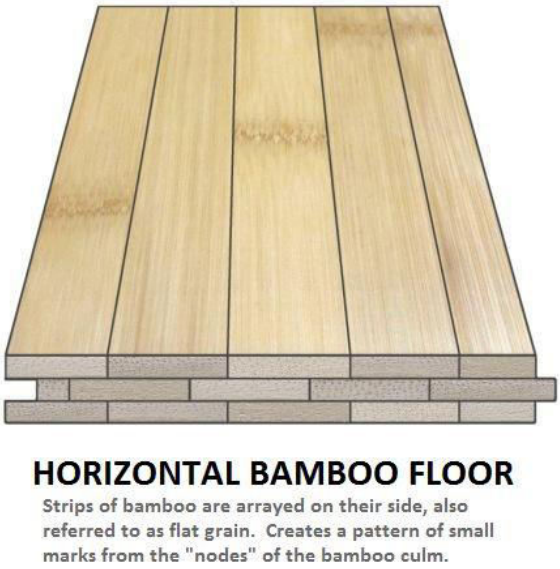

Fig.2 Bamboo flooring

3. Walls

The most extensive use of bamboo in construction is for the walls and partitions. The major elements, the posts and beams, generally constitute part or structural framework. They are to carry the self-weight of building and loads imposed by the occupants and the weather. An infill between framing members is required to complete the wall. The purpose of the infill is to protect against rain, wind and animals, to offer privacy and to provide in plane bracing to ensure the overall stability of the overall structure when subjected to horizontal forces.

4. Roofing

The roof offers protection against extremes of weather including rain, sun and wind, and to provide shelter, clear and usable space beneath the canopy. Above all it must be strong enough to resist the considerable forces generated by wind and roof coverings. In this respect, bamboo is ideal as a roofing material- it is strong, resilient and light weighted. The bamboo structure of a roof can comprise of purlins, rafters and trusses.

a) The simplest form consists of a bamboo purlin and beams, supported on perimeter posts. Halved culms are then laid convex side down, edge-to-edge, spanning from the ridge to the eaves. A second layer, convex side up, is then laid to cover the joints.

B) Corrugated sheets made out of bamboo are also used commonly as roof covering. The bamboo mats are dipped in resin, dried and heat pressed under pressure in a specially made platen, to give strong, reliable sheets of bamboo, which is lightweight. It has good insulation properties too.

c) A layer of bitumen is sandwiched between two mats of bamboo forming a semi rigid panel. The mats can be fixed to rafters at 200-250mm center to center. A bituminous or rubberized weatherproof coating is then applied to the finished roof.

d) Plastered bamboo: A cement plaster, with or without the addition of organic fibers, is traditionally applied to bamboo roofs, to get stronger roof coverings. Various forms of trusses are also adopted using bamboo culms of diameter ranging from 40mm-100mm. The king post trusses are the most common and the simplest.

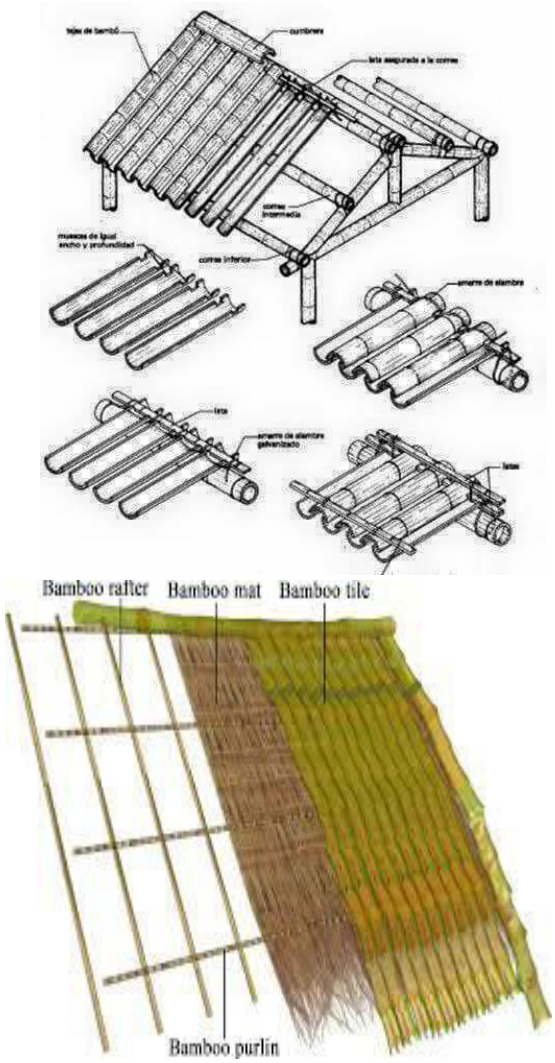

Fig.3 Bamboo Roofing

5. Scaffolding

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. Only lashed joints are used. The cane extension is carried out by lashing the cane ends together with several ties. The ties are arranged in such a way that forces acting vertically downwards wedges the nodes in the lashing. The vertical and horizontal canes used for scaffolding are almost exclusively joined using soft lashing. This technique has the great advantage that the joints can be re-tensioned to the right degree without difficulty and also quickly released again.

Fig.4 Bamboo Scaffolding

THE 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. Recommendable methods: Splitting: 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. Cutting with a machete-type or knife used for cutting.

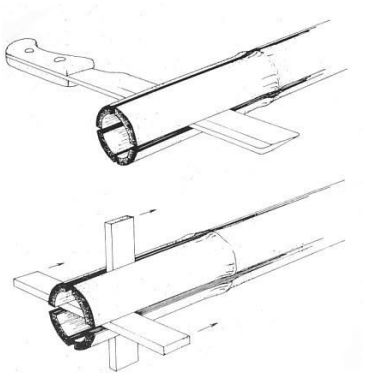

Fig.5 splitting of bamboo

JOINERY DETAILS

Effective jointing is fundamental to the structural integrity of a framed construction. Furthermore, the suitability of a material for use in framing is largely dependent upon the ease with which joints can be formed. Because of its round, tubular form, jointing of two or more bamboo members requires a different approach to that adopted for, say, solid timber. Despite its relatively high strength, bamboo is susceptible to crushing, particularly of open ends. It is also characterized by a tendency to split; the use of nails, pegs, notches or mortises can therefore result in considerable reductions in strength. Connections must also cope with variations in diameter, wall thickness and straightness. Clearly, these limitations have not presented an obstacle to the use of bamboo in traditional forms of construction. However, the building of structurally efficient, more durable and possibly larger and more economical bamboo structures will depend to a large extent on improvements and developments in jointing technology. Traditional joints Traditional jointing methods rely principally on lashing or tying, with or without pegs or dowels.

The basic joint types are:

- Spliced joints
- Orthogonal joints
- Angled joints
- Through joints
- Multiangular joints

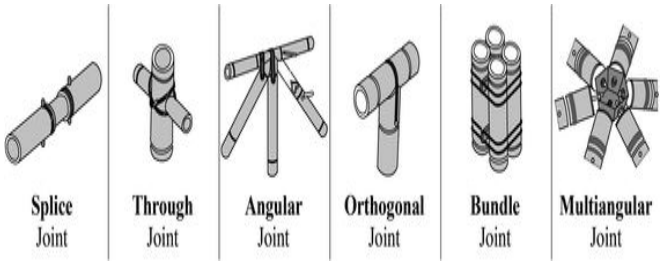

Fig.6 Joinery Details

ADVANTAGES OF BAMBOO

The various advantages of bamboo are mentioned below:

1. Light, strong and versatile
2. Environment friendly
3. Accessible to the poor
4. Self renewing resource
5. Fast growing
6. Highly productive

DISADVANTAGES OF BAMBOO

The major disadvantages of bamboo are as follows:

1. Requires preservation

2. Shaped by nature.

3. Durability–bamboo is subjected to attack by fungi, insects; for this reason, untreated bamboo structures are viewed as temporary with an expected life of not more than 5 years.

4. Jointing–although many jointing techniques exist, their structural efficiency is low.

5. Lack of design guidance and codes.

6. Prone to catch fire very fast by the friction among the culms during wind, and is seen to cause forest fires.

CONCLUSION

Since time immemorial, bamboo has played an important role in the development of mankind. It is used for a wide range of day-to-day purposes, both as a woody material and as food. It has been the backbone of much of the world's rural life and will remain so as the population increases. The properties as top grade building material and increased availability of bamboo in our country makes it possible to use, bamboo in the field of construction extensively. Its high valued utilization not only promotes the economic development, but also saves forest resources to protect our ecological environment as a wood substitute. As an economic building material, bamboo's rate of productivity and cycle of annual harvest outstrips any other naturally growing resource, if today you plant three or four structural bamboo plants, then in four or five years later you will have mature clumps, and in eight years you will have enough mature material to build a comfortable, low cost house.

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