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Bamboo Housing - A Sustainable Housing with Low Energy and Cost Effective Solution in India

Dr. Sunil Prasad Shrivastava
Assistant Professor of Civil Engineering School of Planning and Architecture, New Delhi, India

Abstract: ***A major problem in our society is lack of affordable, economical and sustainable housing due to the rapidly increasing population in both urban as well as rural areas and the solution for this is bamboo housing.***
Since it is grown all over the world in both tropical as well as non tropical areas thus its easily available.
Bamboo is very durable, highly sustainable, earthquake resistant material with high strength. It is naturally available and very versatile material, which is going to become a great alternative material for construction of buildings in upcoming future.
Not just for building construction but it can also be used in various other products such as chair, tables, bookshelves, bedpost etc. The structural properties of bamboo like its axial tensile and axial compressive strength, hygroscopic nature, fire resistance, flexibility in design makes it ideal for construction. Bamboo is becoming most economical, renewable and fast growing construction material in future replacing other materials like bricks, concrete, steel, aluminum etc. Bamboo housing is the future of construction.
Keywords: Bamboo fibers, Bamboo poles, Bamboo tubes, Bamboo strips, Woody grass.

I. INTRODUCTION

India is one of the most rapidly developing countries of the word. The rapid growth of population in the developing country like India has compelled to develop its infrastructure in order to meet with the pace of development. This in turn has resulted in acute shortage of housing particularly in urban areas. India has been experiencing urbanization at an extremely rapid rate in the past two decades. Currently it has more than 508 million urban populations. Our urban population is expected to reach a figure close to 600 million by 2031. As per reports published by RICS-Knight Frank, an additional 25 millions affordable units will be required by 2030. The Economical Weaker Section (EWS) and Low Income Group (LIG) people are primarily driving India's urban housing shortage. There is a huge supply gap for urban housing and more so in the EWS and LIG category. Besides this in India, most of the houses constructed in villages and towns are either one story or two stories high. The span of rooms is 2.5 m to 3.5 m. Under these circumstances, Bamboo house is the best suitable option. It also meets the demand of affordable housing in the country. The housing shortage of the country can be overcome within lesser funds, without compromising with the quality control. The Bamboo as a construction material has become most popular in India because of its distinct qualities like longer durability, high sustainability, good earthquake resistance and high strength etc.

Bamboo is naturally available in the tropical areas of Southeast Asia and other parts of the world and become a good alternative material for construction of building. Bamboo is a versatile material and can be used in construction in various ways in form of exterior and interior decoration of house. In addition Bamboo generates a
cool environment by offering effective heat insulation. Hence Bamboo has become popular construction material for Architect and Engineers.

II. NEED OF BAMBOO AS CONSTRUCTION MATERIAL

In order to meet the shortage of housing in India specially in rural areas among Economically weaker section (EWS) or Low income group (LIG) people, there is need to explore affordable housing material which must be simple in construction, independent, high performance and requires less workmanship.

In order to increase the economic viability and sustainability of the product, simple equipment and process has been adopted that use locally available men and materials.

Bamboo has been in use by the people since long back. The probable reason for the adoption of bamboo as construction materials might have been easily available ecofriendly and fire resistant construction materials. Also the structural elements of bamboo has good load bearing capacity. It has high strength and low weight. It is most versatile material and due to this reason it is widely used in different forms.

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In addition to its use as structural elements, it can also be used to make bamboo furniture products (chairs, tables, book shelves etc.), lighting fixtures, bed posts, bamboo fencings, bamboo flooring, arts and craft for the decoration of bedroom, kitchens, gardens etc. This is because of its appearance, strong moisture resistance, fire and heat resistance capacity in comparison to wood as a construction material.

Also bamboo is the world's fast growing (approximately 7.5 to 40 cm in a day) woody grass. It grows approximately three times faster than other species. Bamboo is also good in biomass production. It is grown along banks of river and other vulnerable areas to protect against soil erosion.

The material is relatively cheap and durable, can provide infinite flexibility in plan form as it can be easily bend, give desire shape and can provide joint to suit the construction. It also offers an attractive external appearance. Furthermore, bamboo house can be constructed without heavy capital investment on the part of the builder.

III. STRUCTURAL PROPERTIES OF BAMBOO

A. Axial Tensile and Axial Compressive strength

The axial tensile strength parallel to the fibers of bamboo is very high in comparison to its compressive strength. It is found that the average tensile strength of bamboo along the fiber varies between 70-210MPa whereas the tensile strength of wood fibers is found only at the extent of 50MPa, which is weaker than the bamboo fiber in resisting tensile stress.

The axial compressive strength of bamboo fiber has been found more in the slimmer tube with lower diameter due to the major part of its outer skin in comparison to the tube with larger diameter, which is having minor part of the outer skin. The average compressive strength of bamboo varies between 20-65MPa.

B. Elastic Modulus

Bamboo has got accumulation of highly strong fiber at its outer part of the tube and due to this it has got higher value of elastic modulus like shear and bending strength. The quality of bamboo depends upon its elastic modulus. A bamboo having higher elastic modulus is called high quality bamboo and vice versa. The elastic modulus of bamboo varies between 2500-17500MPa.

C. Shrinkage

Bamboo is an hygroscopic material which absorbs water from the environment The mechanical properties of bamboo is greatly affected by moisture content present in the bamboo. Bamboo shrinks more when it loose water. It shrinks in a cross section of 10-15% and a wall thickness of 15-17%. Hence it is required to get it completely air dried before use as air-dried bamboo shows good strength as compared to oven dried.

D. Anisotropic Properties

Bamboo has got completely different properties in longitudinal and lateral direction as it contains cellulose fibers in the longitudinal direction and lignin in the lateral direction. Cellulose fibers are strong and stiff whereas lignin is soft and brittle. Hence Bamboo can be considered as transverse isotropic material.

E. Fire Resistance

Bamboo is very good fire resistance material. Due to its naturally presence of high percentage of silica content and insect treatment with boric acid, bamboo poles can resist fire and temperatures up to 400 degree Celsius. In addition bamboo contains very few volatile oils, which causes very hard to ignite even with direct flame.

F. Suitability of Bamboo as Structural Material

Since Bamboo is a strong and flexible building material, it gives wider range of flexibility in design. The bamboo strips can be folded, bent or swayed to give any shape without breaking. It is the material of great choice for the designers. For building arches, curved roofs and other architectural features have become very simple by using bamboo as construction material. It can be used to construct bridges and other structures that need stability and support. Bamboo poles can be used as beams and columns to create a sturdy framework when constructing homes and other structures.

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Fig 1: Use of bamboo poles and folded bamboo strips in a bamboo house



Fig.2: Use of bamboo arch and bamboo sticks in a bamboo house

In addition, Bamboo as a construction material is very much suitable to resist horizontal forces like Earthquake or wind forces due to it flexibility and energy absorption capacity. So, it can also be used in the areas, which are prone to earth quake/wind forces.

IV. CONCLUSIONS

Bamboo plants are grown all over the world in tropical and non-tropical region and more common in Asia pacific regions.

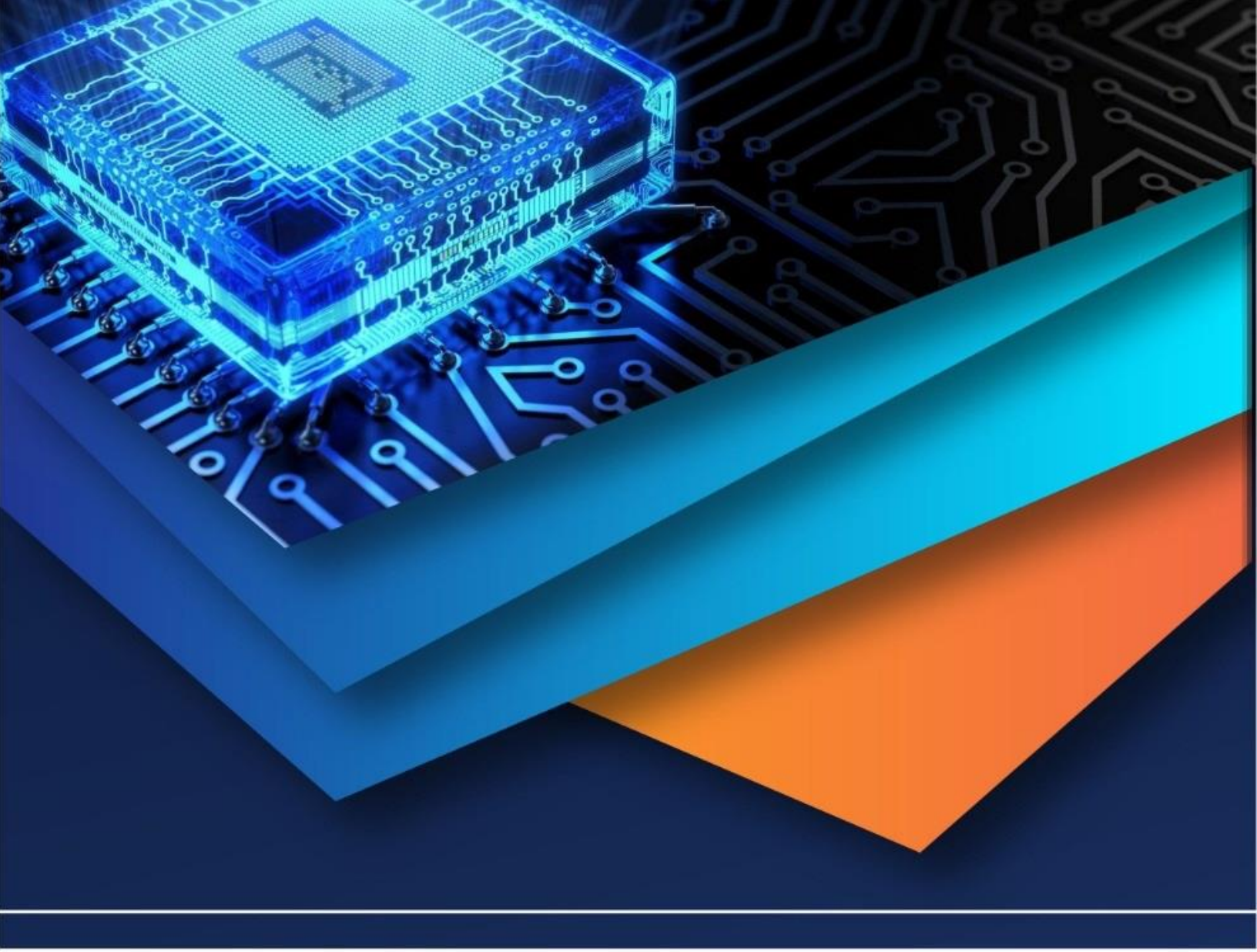
It is very much versatile material and can be used for all types of construction because of its structural quality. It's strong, flexible, durable, environment friendly and low cost building material. Bamboo can be used for both temporary and permanent structures. It can also be used as a part of composite structures.

Bamboo is being slowly recognized as a renewable, fast-growing & most economical material for construction that may replace the contemporary materials, if treated carefully. It reduces the consumption of natural wood, which is responsible to protect our environment by providing a replacement.

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