Alternative Walling System for Low Cost Housing by using Bamboo

Sushil G. Nikam A.C. Attar

Abstract- The use of bamboo as a structural construction material is gaining traction primarily because it is a rapidly growing material and thus sustainable, and it has many positive engineering attributes such as its high strength and Durability. This work takes into consideration the alternate construction material for walling system by using Bamboo . In this project the one type of bamboo-based construction is examined and experimental results are carried out, thus confirming that this type of construction is a viable alternative for walling system for low cost housing.The goal of assessing bamboo's potential to meet regional housing needs in a low-cost, eco-friendly manner.This increased civil society awareness on bamboo's potential as a construction material

Keywords: bamboo, structure, construction, affordability, housing, materials.

I. INTRODUCTION

The shortage of housing in developing countries motivates the search for low cost materials that can be applied in the construction of affordable houses for poor people. Many researchers have been studying the application of the locally abundant natural materials as building materials such as mud blocks, natural fibers reinforcing soil or cement etc. These materials and the traditional building techniques, which almost have vanished after the wide implementation of the building industry, are the main focus of the researchers on non-conventional materials and techniques at the present time of environmental crisis, which our globe is facing. In recent years the demand for structural wooden products for building materials has increased with increasing construction of housing. On the other hand, the quantity and quality of wood resources from the forest have been decreasing. Consequently, the search for substitute materials in place of the traditional uses of wood has been renewed by Bamboo. In particular, is considered a promising alternate material because of its fast growth rate, short rotation age, and high strength. There is always need of low cost mass housing schemes for people earthquake affected areas, emergency structures in different situations. With the aim to utilize strength properties of bamboo in low cost housing research project work is undertaken on Alternative walling system.

Bamboo reaches its full growth in just a few months and reaches its maximum mechanical strength in just few years. Its abundance in tropical and subtropical regions makes it an economically advantageous material.

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Dr. A.C. Attar, is working as professor in the department of civil engineering, Rajarambapu Institute of Technology , Sakharale, Shivaji University Kolhapur, India.

Mr.Sushil G. Nikam, M.E. student in the department of civil engineering , Rajarambapu Institute of Technology, Sakharale,Shivaji University Kolhapur, India.

Some of the positive aspects such as a lightweight design, better flexibility, and toughness due to its thin walls with discretely distributed nodes and its great strength make it a good construction material.

The objectives of the present study are:

- Use of Bamboo as a construction material.
- Study and development of alternative walling system for lowcost housing by using Bamboo.

II. GENERAL INFORMATION ABOUT BAMBOO AND ITS CHARACTERISTICS.

A. Geographical Distribution

Bamboo occurs in tropical, subtropical and temperate regions of the world, wherever suitable ecological factor exist. Accordingly it is found in the belt extending from India to Japan (including Chin and South East Asia), in Africa and Australia, and in the region extending from Southern United States to Argentina and Chile. It is not found in colder temperate regions such as Canada, Europe and the U.S.S.R. Bamboo thrives in monsoon forests and prefers well-drained sites which are not waterlogged. It dwindles into under shrubs and grass in temperate regions.

It occurs in a variety of soils which are neither too acidic nor too alkaline. No data appears to be available on the world-wide production of bamboo. However, In India alone a total area of 0.8 million hectares is estimated to be under cultivation, yielding about 20 GN of bamboo annually·

B. Physical Properties Of Bamboo

A.Specific Gravity:

The specific gravity of bamboo increases with its age till maturity, and depends also on the species and the moisture content. Also, the outer part of the bamboo is 'somewhat heavier than the inner part. The average specific gravity ranges from 0.3 to 0.8. The specific gravity of mature culms will be between 0.5 and 0.8.

B. Durability and resistance to fire:

Bamboo is vulnerable to attack by insects such as borers and termites, and rot fungus. Untreated bamboo in contact with ground has a maximum life of 2 years while bamboo under cover and not in contact with ground may last from two to five years.

Several techniques are available for the chemical preservation of bamboo. However, one method which has proved to be very effective is the ASCU method, whereby bamboo could be protected for at least 20 years. This method developed by the Forest Research Institute, Deharadun (India) bamboo is treated with a solution of arsenic pent- oxide, copper sulphate, and sodium dichromate. Not much work has been done on the fire protection of bamboo.

A reasonably cheap fire resistant composition comprises ammonium phosphate, boric acid, copper sulphate, zinc chloride and sodium dichromate.

C. Engineering Properties: -

***i Factors Influencing Strength*:**

The strength of bamboo has been investigated by several research workers around the world. It is influenced by various factors, such as the species, soil and climatic conditions, harvesting, age ,moisture content in the samples, location of the sample with respect to the length of culm, presence or absence of nodes in the test specimen and decay, if any. For any given species, bamboo harvested at an early age possesses lower strength and modulus than bamboo harvested after reaching maturity. (3 to 6 years). In general, the strength of bamboo is less at the nodes than in the internodes; it .also decreases somewhat from the basal to distal end of the culm.

ii Behavior in compression:

Bamboo possesses significantly lower strength in compression that in tension. Compressive ranging from 29 N/mm square to 88.7 N/mm square has been reported. The stress-strain behavior of bamboo in compression slightly non-linear. The initial modulus of elasticity is of the order of 4.6 KN/mm square to 19.4 KN/mm square. The strength and the modulus of elasticity decrease with increasing moisture content. The strain at failure has been reported to vary from 3.2x10 -3 units to 12x10-3 units.

III. III. DEVELOPMENT OF BAMBOO WALL PANELS

A. Introduction

Bamboo is available in commercial quantities using the established supply system. It is a renewable plant with a short rotation period. Bamboo grows to its full size for about a year. Another two or three years are required for the plant to gain its high strength. Bamboo can be grown even on degraded land. Construction materials from bamboo should be treated in order to achieve longevity. The use of high energy materials, like cement or steel, is minimised. Therefore the adoption of bamboo for house construction helps preserve the environment.

B. Material Required for Bamboo Wall Panel

The construction materials for building a bamboo house should be readily available and accessible. The bamboo based house has a very low weight therefore foundations can be minimized. Basic materials for house components (bamboo, nails, wooden batten) are inexpensive. Bamboo can tolerate high values of deformations in the elastic range i.e. possesses high elasticity. Therefore bamboo houses when properly constructed are ductile i.e. being able to sway back and forth during an earthquake, without any damage to the bamboo wall panel.

C. Checklist for obtaining construction quality bamboo .

1. Depending on the species, 3 to 5 year old bamboo is best for construction purposes.
2. The bamboo should be harvested in dry season in order to avoid fungus attack and excess pole moisture.
3. Use the appropriate species for the particular application.
4. Do not expose the bamboo to direct sun, moisture and rain.
5. Use only straight portions from the bamboo culms for construction.
6. Bamboo should be treated against insects and fungus.

D. Making of Wall Panel

1. Select the bamboo as per the checklist , the approximate length of single rounded bamboo 25 to 30 ft.
2. Remove the bottom and topmost part of bamboo as it is not useful because it is solid in nature.
3. Cut the rounded bamboo in required height of wall panel i.e.10 to12 ft.
4. Split the bamboo vertically in to two parts
5. By using wooden batten prepare a frame of required size of wall panel .
6. Fix the splited bamboo vertically on both sides of frame by using nails.

Fig.1-Bamboo wall panel

IV. COMPRESSION TEST ON WALL PANEL

Test is carried out on the universal testing machine.

A. Sample Details-

Test Type - Compression
Material - Wood (Bamboo)

B. Test Parameters-

Width - 300 mm,
Thickness - 65 mm,
C/S Area - 19500. 00 mm^2

i. Sample No 1

Table 1- Load Displacement Table -

Sr. No	Load (KN)	Displacement (mm)
1	17.9	8.4

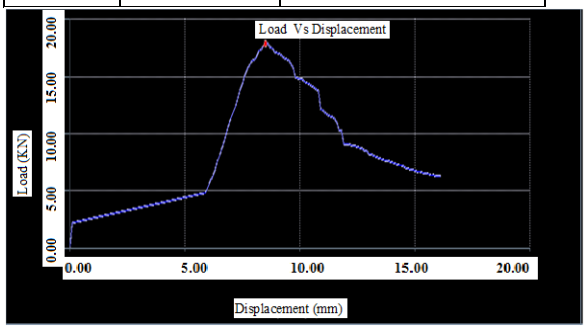

Fig- 1 Load Vs Displacement

Fmax – 17.9 KN
Displacement at F max – 8.4 mm

iii. Sample No 2

Sr.No	Load (KN)	Displacement (mm)
1	15.64	7

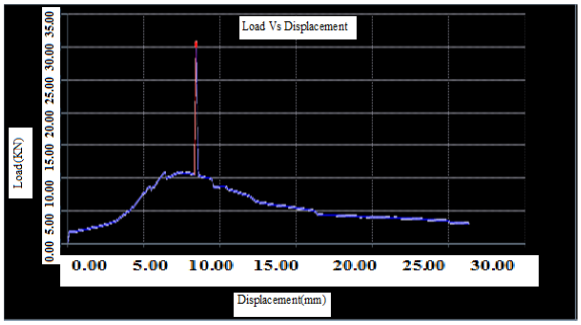

Fig- 2 Load Vs Displacement

F max – 15.64 KN
Displacement at F max – 7 mm

ii. Sample No 3

Table 2- Load Displacement Table -

Sr. No	Load (KN)	Displacement (mm)
1	14.44	8.4 mm

V. PLANNING AND LAYOUT

The planning of the proposed housing as well as the layout of structural members are presented below.

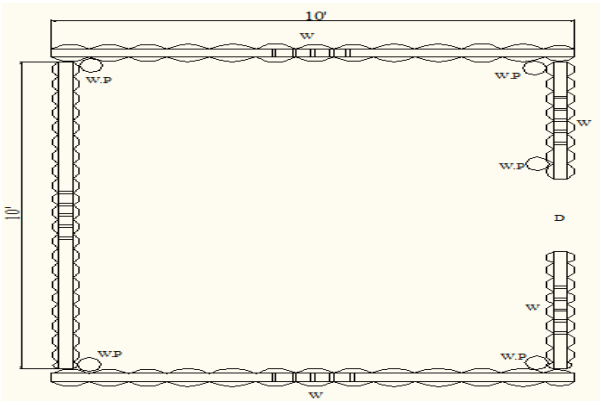

Fig- 4 Top View

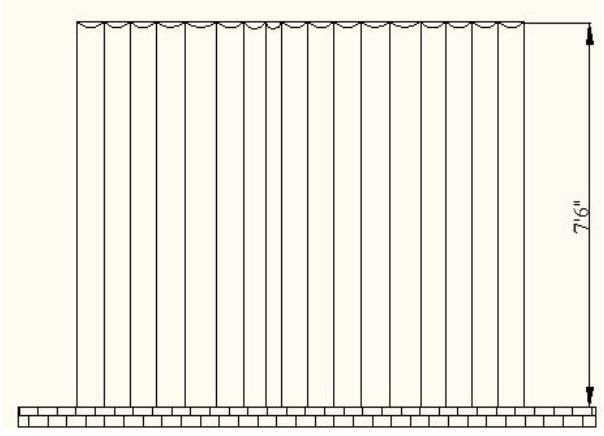

Fig- 5 Side View

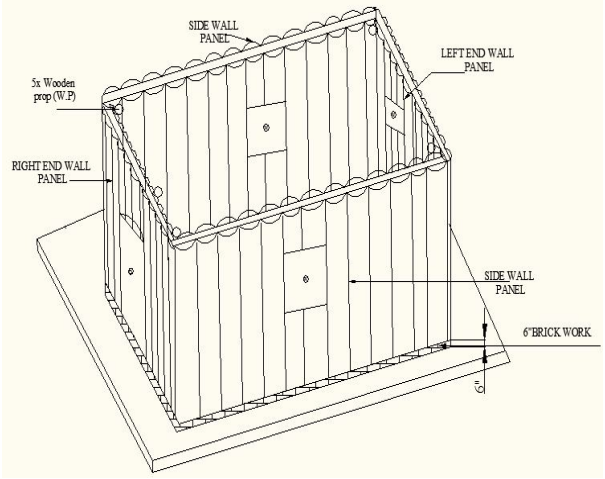

Fig- 6 Open Rroof 3- D VIEW

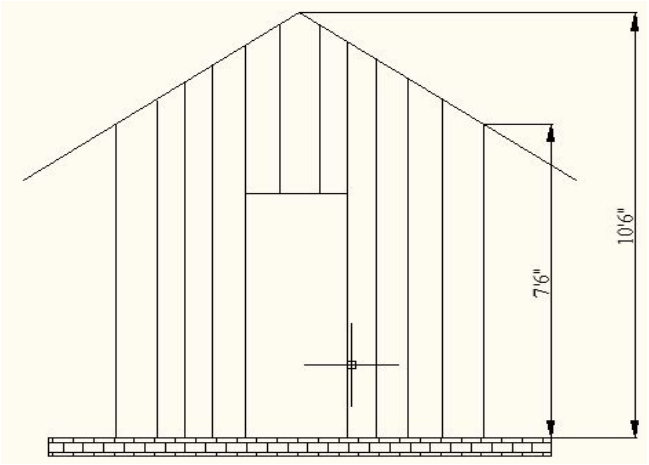

Fig- 7 ELEVATION

Fig- 8 Complete Picture of Bamboo house.

VI. ESTIMATE SHEET FOR BAMBOO HOUSE 10 FT X 10 FT

Eave Height = 7'6" Ridge Height = 10'6"

Sr. No	Item	Description of Material	Quantity	Length per piece of bamboo	Unit	Total length of Pieces (ft)	price per foot	Total (INR)
1	along width	Right End Wall Panel W = 10 ' Avg. Ht. = 9' (Full Round Bamboo)	100 No.	9.0	ft	900	3	2,250
2	along width	Left End Wall Panel W = 10 ' Avg. Ht. = 9' (Full Round Bamboo)	100 No.	9.0	ft	900	3	2,250
3	along Length	Side Wall Panel L = 10 ' Avg. Ht. = 7'6" (Full Round Bamboo)	100 No.	7.5	ft	751	3	1,878
4	along Length	Side Wall Panel L = 10 ' Avg. Ht. = 7'6" (Full Round Bamboo)	100 No.	7.5	ft	751	3	1,878
5		Nails	8 No.	1	kg	8	50	400
6		Wooden Props	5 No.	1	no.	5	140	700
7	For 4 wall panel	Wooden Batten For wall panel ; 4 Nos.(size: 70' X 0.125' X 0.125')	280 No.	0.015625	Cu. ft	4.375	450	1968.75
Roof								
1	At roof	Bamboo Mat (7,6" x 15')	2	-	-	-	130	260
2	purlins	Full Round Bamboo	10	15.0	ft	150	4	600
3		plastic paper at roof	250	1	Sq ft	250	2.25	562.5
4		grass panel (7,6" x 15')	2		-	-	500	1000
5		varnish	4	1	lit	4	70	280
Treatment								
1	Chemical	Boric Acid	3	1	kg	3	120	360
2		Borax	3	1	kg	3	150	450
Labour Charges			625	1	Sq.ft	625	10	6250
							TOTAL= Rs. 21087/-	

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VII. CONCLUSION

1. In nations such as India, bamboo is a well established building component but generally seems quite poorly implemented.
2. Bamboo has known qualities and an established reputation of being a wonder building material (eco friendly, regenerative, low cost etc.)
3. From detailed estimation it is found that per square meter cost of bamboo house is one fourth of the R.C. construction.
4. For buckling test of bamboo wall panel the average load carrying capacity is 15.99 KN and aveage max. displacement is 7.99 mm.
5. With the help of simple techniques any member of society could purchase bamboo cheaply and instantly improve their living conditions and immediate environment.

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AUTHORS PROFILE

Dr. A.C. Attar, is working as professor in the department of civil engineering, Rajarambapu Institute of Technology , Sakharale, Shivaji University Kolhapur.

Mr.Sushil G. Nikam, M.E. student in the department of civil engineering , Rajarambapu Institute of Technology, Sakharale,Shivaji University Kolhapur.