International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 58-63 www.ijaem.net ISSN: 2395-5252

Bamboo for Ferrocrete-I

Prof. Avinash Sakate[1], Mr. Sangram Ombase[2], Miss Ayesha Shaikh[3],Miss Diksha Jadhav[4], Mr. Rohit Jadhav[5]

Lecturer, Applied Mechanics Dept., Govt. Polytechnic, Karad, Maharashtra, India [1]
S.Y. Student, Civil Engineering Dept., Govt. Polytechnic, Karad, Maharashtra, India[2,3,4,5]
Corresponding Author: Prof. Avinash Sakate

Date of Submission: 23-09-2020 Date of Acceptance: X-X-2020

ABSTRACT: Bamboo is highly regarded as a reliable, renewable and versatile building material in many tropical regions. The plant is one of the world's oldest natural building materials and serves as an important resource for sustainable building in today's eco-conscious world. In this work, we will be discussing about bamboo as alternative material to steel. Ferrocement or Ferrocrete is light weight and thin walled construction in which thin wire mesh is used. Bamboo is eco-friendly, economical and easily available material. We can use bamboo as reinforcement material instead of steel for non-permanent structure.

KEYWORDS: Bamboo, Ferrocement, Ferrocrete, bamboo mesh, etc.

I. INTRODUCTION

Ferrocrete is he composite of Ferro (Iron) and cement (cement mortar). It is a composite, formed with closely knit wore mesh; tightly wound round skeletal steel and impregnated with rich cement mortar. Application of ferrocement in all fields of civil engineering constructions, dams, bridges, silos, water treatment plants, sewage, building components, water and soil retaining structures, space structures, domes, boats, conduits, bunkers.

In this work the focus is to provide lot of information in few words and detailed summary of bamboo as a structural material in construction. In our work we are focusing on checking suitability of bamboo for ferrocrete units. It must be necessary that to check the sustainability of bamboo ferrocerete as structural member which gives better result with better economy.

Objectives

The study consists of the following specific objectives;

- To study the concept of ferrocrete & its properties. Also its various applications in construction work.
- To study the physical and mechanical properties of bamboo.
- To check the suitability of bamboo as a structural material in ferrocrete as replacement of steel.
- To suggest the bamboo ferrocerete for constriction application in civil work.

II. LITERATURE REVIEW

Ferrocement is a material in which Portland cement is used in place of concrete and small diameter wire mesh is used uniformly throughout cross section instead of separately placed reinforcing bars. It is combined, formed with closed weaved wire mesh; tightly wound round skeletal steel and saturated with rich cement mortar. With ferrocement it is possible to fabricate a variety of structural elements, may be used in foundation, walls, floors, shells etc. They are thin walled, lightweight, durable and have high degree of impermeability. It combines the properties of thin sections and high strength of steel. In addition, it needs no formwork or shuttering for casting. [1]

2.1 Ferrocement

A thin walled construction, consisting of rich cement mortar with uniformly distributed and closely placed layers of continues and relatively small diameter mesh [metallic or other suitable material]. [1]

2.2 Historical background

An idea of permeate closely spaced wire meshes with rich cement mortar is similarly to the kood type of age-old method of walling. In kood system, bamboo and reeds are tied closely together and filed in with a mix of mud and cow dung as a matrix. It is used in rural areas of India. Hence ferrocement may be called as a modified form of kood standardized raw materials, systematic method of construction and reliable structural properties.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 58-63 www.ijaem.net ISSN: 2395-5252

Hence the mesh is used in place of bamboo and reeds, and cement mortar instead of mud. [1]

Mr. J. L. Lambot in France. He constructed a ferrocement rowing boat in 1848, in which reinforcement was in the form of flexible woven wire mat and small size bars. He has patented this process. [1]

2.3 Why bamboo?

Bamboo has historically been used as a building material due to its inherent properties, being regenerating biodegradable, with high tensile strength and light weight. It is here that engineered bamboo can be of great value to civil engineers. Bamboo possess excellent flexure and tensile strength. Bamboo is a versatile, strong, renewable and environment friendly material. Some bamboos grow up to 1 meter in a day. India is the second richest country in bamboo genetic resource after China.

2.4 Properties of Bamboo

Following are some properties of bamboo;

Table 2.1: Properties of bamboo [3]

Sr. No.	Property	Value
1.	Specific Gravity	0.575 to 0.655
2.	Average Weight	0.625 kg/cm^2
3.	Modulus of Elasticity	1.5 to 2.0x105 kg/cm^2
4.	Safe working stress in compression	105 kg/cm^2
5.	Safe working stress in tension	160 to 350 kg/cm^2
6.	Bond stress	5.6 kg/cm^2

2.5 Limitations and precautions

The bamboo is gathered from the rural areas, but in many areas productions or cultivation of bamboo is reduced due to poor management. It is can be attacked by insects and fungi. The life span of bamboo reduces when it comes in ground contact. It is necessary to a carry out proper precautions and treatments should be carried out on selected bamboo species before using bamboo as reinforcement. An effective moisture proof treatment is necessary for bamboo reinforcement. Hence any suitable water repellent substances are used to improve properties of bamboo such as durability, resistance to water absorption and bonding strength. [3]

III. MATERIALS

Generally, materials using for bamboo ferrocerete are;

- Bamboo mesh

Rich cement mortor.

3.1 Bamboo mesh

Bamboo wire mesh reinforcement is the basic element of ferrocement or Bamboo for ferrocrete concrete. The number of layers of mesh, decide the thickness of composite. Meshes used generally in ferrocement structures are having opening sizes in mm as 25 x 50, 50 x 50, 75 x 75, 100 x 100 and 150 x 150.

In case of bamboo mesh the thickness of mesh is primarily depends upon the degree of cutting of bamboo for making mesh. If we cutting the bamboo strips in proper manner or in desired size, then we will getting better result as concerned the specific surface of bamboo mesh. Bamboo mesh of rectangular pattern as shown in fig. 3.1.

Fig.3.1: Rectangular Bamboo mesh

3.2 Cement mortor

Mortor used in bamboo ferrocrete primarily consists of cement as binder, sand as fine aggregate and water. Normally the aggregate consists of well graded fine sand passing from 4.75 mm sieve is used. Generally, OPC 43 or 53 grades is used in ferrocement. The mixing water should be fresh, clean and potable.

3.3 Proportioning of cement mortor

Normally rich cement mortars of mix proportions of (1:1.5) to (1:4) by volume are used in ferrocement. When sand content is increased, its water requirement goes up to maintain the same workability. [1]

In this work, we were use the proportion of mortor of 1:3. Hence to obtain strong, dense and mortors trial mixes should be taken. Because of mortor with low workability creates the problem of harshness.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 58-63 www.ijaem.net ISSN: 2395-5252

IV. EXPERIMENTAL WORK AND RESULTS

In general, techniques used in conventional ferrocrete construction need not be changed when bamboo is to be used for reinforcement. But the testing on preliminary materials is necessary, while before used in bamboo reinforced ferrocrete.

4.1 Tests on materials

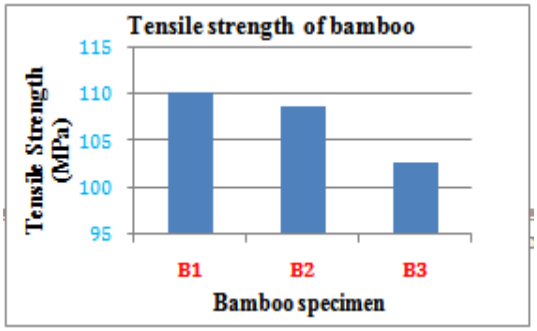
4.1.1 Tensile strength of bamboo: In order to conduct the tensile tests, it was necessary to prepare the bamboo samples. Proper gripping is an important factor for tensile test, because bamboo is relatively soft materials than the materials used for gripping purpose in UTM. The application of GI spiral around the ends of bamboo specimen has been shown in figure 4.1.

A specimen of length 60 cm was prepared with a grip portion of 15 cm on each side of the specimen. The grip portion is binding with Galvanized Iron wire and rubber as shown in Fig. 4.1.

Fig. 4.1: Tensile test specimens of bamboo

Bamboo specimen	Gauge length (mm)	Area (mm^2)	Load (KN)	Tensile strength (N/mm^2)	Failure type
B1	600	132.66	14.607	110.35	Grip
B2	600	140.28	15.27	108.85	Grip
B3	600	138.74	14.25	102.71	Grip
Average tensile strength				107.30	

Table 4.1: Tensile strength of bamboo specimen



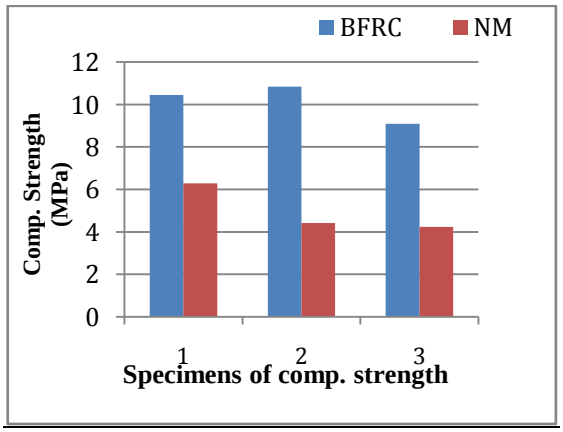
Graph 4.1: Tensile strength of bamboo specimen

4.1.2 Compressive strength of cement mortor: Determination of compressive strength of cement mortar mix having proportion 1:3 were done as per IS 4032-1968 and IS 650-1966. Cement mortar was prepared by using cement and sand in proportion 1:3 by weight and keeping w/c 0.6. The average compressive strength of 3 days & 7 days was obtained 11.9 MPa & 20.33 MPa respectively.

4.2 Tests on bamboo Ferrocrete specimens

4.2.1 Compressive strength of bamboo ferrocrete: The cube specimen having dimensions 150mm X 150mm X 150mm are casted using cement mortar in proportion 1:3 at water cement ratio 0.6. Bamboo mesh is prepared in dimensions of 140mm X 140mm. It is laid in one layer in specimen.

Compression tests were carried out on the specimens (both bamboo ferrocrete & normal mix) after 7 days of curing. The specimens were tested using a 40 T Universal Testing Machine. Then the result was found to be summarized in **Table 4.2.**

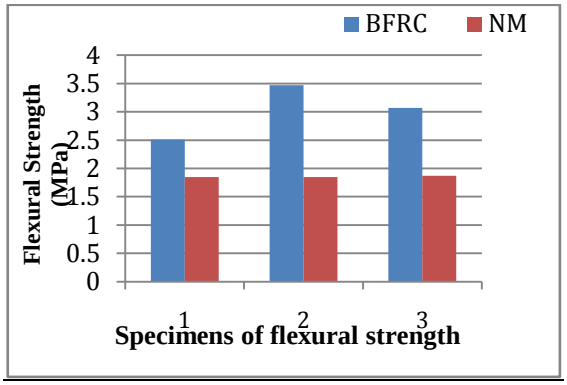


Graph 4.2: Compressive strength of specimens

4.2.2 Flexural strength of bamboo ferrocrete & normal mix: Flexural tests were carried out on the specimens (both bamboo ferrocrete & normal mix) after 7 days of curing. The size of mould is 500 mm

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 7, pp: 58-63 www.ijaem.net ISSN: 2395-5252

X 10 mm X 100mm are casted using cement mortar of proportion 1:3 at water cement ratio 0.60. The specimens were tested using a 40 T Universal Testing Machine. Then the result was found to be summarized in **Table 4.3.**



Graph 4.3: Flexural strength of specimens

Table 4.2: 7 Days Compressive strength ofbamboo ferrocrete& normal mix

ID mark of Cube	Dimension (mm)	Area (mm^2)	Load (kN)	Comp. Strength (MPa)	Avg. Comp. Strength (MPa)
BFRC-1	150 x 150 x 150	22500	234.92	10.44	**10.12**
BFRC-2			244.00	10.84	
BFRC-3			204.64	9.09	
NM-1	150 x 150 x 150	22500	141.52	6.28	**5.04**
NM-2			99.52	4.42	
NM-3			95.32	4.23	

Table 4.3: 7 Days flexural strength of bamboo ferrocrete& normal mix

ID mark of Cube	Dimension (mm)	Span (mm)	Breaking Load (kN)	Flexural Strength (MPa)	Avg. Flexural Strength (MPa)
BFRC-1	L = 500 mm B = 100 mm H = 100 mm	400	6.28	2.51	**3.07**
BFRC-2			8.68	3.47	
BFRC-3			8.08	3.23	
NM-1	L = 500 mm B = 100 mm H = 100 mm	400	4.64	1.85	**1.85**
NM-2			4.64	1.85	
NM-3			4.68	1.87	

V. CONCLUSION

- Bamboo should season for at least three months before using it as reinforcement.
- From the test analysis, bamboo can potentially used as substitute for steel reinforcement. As bamboo is eco-friendly material, limiting the use of steel can reduce carbon dioxide emissions.
- If tension tests are conducted without specimen end preparation actual results may not be found due to smashing at the grip location especially for bamboo specimen, but if grip is prepared by using GI wire then no smashing and slippage occurs at that location. Without end preparation the strength is considerably low because of premature failure at the grip.
- The bamboo reinforced ferrocrete is recommended for lightly loaded, non-permanent structures and low rise constructions.

Fig. 5.1: Bamboo ferrocrete manhole covers

Future Scope Of The Project Work

- It is recommended that further investigation be carried out on bamboo strip ferrocrete design, focusing on the determination of the optimum percentage of reinforcing the mesh in ferrocrete.
- By developing the appropriate technology or design principals of bamboo ferrocrete, the efforts will try to developing small industries in rural areas which can be play vital role in raising per capita income & living standards of rural people.

REFRENCES

[1]. Maharashtra Research Institute, Nashik, "WRD Handbook Chapter No-1 : Ferrocement Technology".
[2]. Humberto C. Lima Jr., Fabio L Willrich, Normando P Barbosa, Maxer A Rosa, Bruna S Cunha, "Durability analysis of bamboo as concrete reinforcement".
[3]. Sabnani, C., Latkar, M., Sharma, U., "Can Bamboo Replace Steel as Reinforcement in Concrete, for the key Structural Elements in a Low Cost House, Designed for the Urban Poor"?
[4]. IS 6874 (2008): Method of tests for bamboo [CED 9: Timber and Timber Stores].
[5]. IS : 4031 (Part 6) - 1988 Indian Standard Methods Of Physical Tests For Hydraulic Cement. Determination Of Compressive Strength Of Hydraulic Cement Other Than Masonry Cement.
[6]. M.S. Shetty, "Concrete Technology Theory & Practice", S. Chand & Company Ltd.
[7]. Ashok Kumar Gupta, Rajiv Ganguly, Ankit Singh Mehra, "Bamboo as Green Alternative to Steel for Reinforced Concrete Elements of a Low Cost Residential Building".
[8]. AjinkyaKaware, Prof. U.R.Awari, Prof. M.R.Wakchaure, "Review of Bamboo as Reinforcement Material in Concrete Structure", International Journal of Innovative Research in Science, Engineering and Technology Vol. 2, Issue 6, June 2013.