Experimental Study on Bamboo Reinforcement-A Sustainable Alternative to Steel

Shweta Rokade[1], Vaishnavi Motghare[2], Nehal Gajabe[3], Amol Deshmukh[4], Pravin Lanjewar[5]
[1]*Assistant Proffesor, Bapurao Deshmukh Collage of Engineering, Sevagram, Maharashtra, India*
[2, 3, 4, 5]*Students, Bapurao Deshmukh Collage of Engineering, Sevagram, Maharashtra, India*

Abstract **- Reduce the cost of the structure and it also ecofriendly in nature Steel is very expensive than the bamboo The motivation for such replacement is typically caused bamboo is rapidly available in many tropical and sub-tropical locations derive to find more sustainable alternatives in the construction industry This review addresses such bamboo reinforced concrete and assesses its structural and environmental performance as an alternative to Steel reinforced concrete In the present research for bamboo sticks had been provided as reinforce concrete beam in place of Steel bar Steel reinforced concrete beam where tested to compare the result obtained for the bamboo reinforced concrete beam bamboo compared with steel it gives high tensile strength. Finally found the solution on literature review was done various types of research papers based on this i find out bamboo as alternative for reinforcement to carryout various test on bamboo like compressive strength tensile strength different percentage at Bamboo reinforced After completion of curing period specimen will test and based on result obtained affordable housing will design.**

Index Terms **- Bamboo, Reinforcement, Steel, Cement, Concrete.**

INTRODUCTION

As per the area, India is counted one of the largest countries in the world and a large area of the country is under developing stage. The primary need of the people living in rural areas is a shed to live in. Due to low availability of conventional materials (like steel) in remote areas and also because of high costs, it becomes difficult to use this material in construction, also the income of the people living in remote areas is not much and hike in prices of these materials is also a factor which affects their dream to live in good home. In construction and demolition the use of technology has changed, new methods, advanced equipments are available and also the use of materials has changed which were used from ages. Owing to these factors for economical and green construction, bamboo reinforcement can be one of the major substitutes of steel for concrete reinforcement. The availability and price of this material for remote area people would be affordable. The adaptation of bamboo as reinforcement material in concrete can help in reducing the high demand of steel reinforcement.

In this Project, bamboo is used as replacement of steel in concrete and the mechanical properties of concrete were compared with traditional concrete. Laboratory experiments were performed to check the reliable use of bamboo as replacement of steel in concrete showing its compressive, tensile and flexural strengh by mean of bamboo reinforced concrete for green construction.

METHODOLOGY

Bamboo reinforced concrete construction follows same design, mix proportions and construction techniques as used for steel reinforced. Just steel reinforcement is replaced with bamboo reinforcement. Properties of bamboo reinforcement, mix proportion of concrete, design and construction technique with bamboo reinforced concrete is discussed in this article. Nature's material, bamboo has been widely used for many purposes. Mainly as a strength bearing material. It is used for building shelters from an earlier time. Bamboo has used for scaffolding works, formwork supporting stands and many in building construction works. These are limited to medium-large projects. Even though existence of bamboo has been found from centuries, bamboo as reinforcement material is an innovation in the civil engineering construction field. This innovation was based on Clemson's study that has been conducted in the Clemson Agricultural College. Bamboo is a biodegradable and renewable in nature. It is energy efficient as it is of natural origin and environmentally sustainable in nature. These

properties have forced to use this in the construction field for centuries.

The steel as a reinforcing material is a demand that is increasing day by day in most of the developing countries. There is situations when the production is not found enough to face the demand for steel. Hence it is essential to have an alternative that is worth compared to steel. Bamboo is found in abundant, they are resilient and hence these can face the demand as a reinforcing material and become an ideal replacement for steel. The tensile strength property which is the main requirement of a reinforcing material is seen appreciable for bamboo, compared with other materials including steel. The structure of bamboo from its origin gives this property. The hollow tubular structure has high resistance against wind forces when it is in natural habitat. Working on the weak points of bamboo and bringing up an innovation of bamboo as a structural steel replacement, would be a great alternative.

To check the practicality and reliability of using bamboo splints is reinforcing material in concrete elements & to select and prepare the most appropriate kind of bamboo specimen to be used in concrete element as reinforcement. The following tests were performed on different bamboo specimens: -

1) Fineness of cement.
2) Sieve test.
3) Consistency of Cement.
4) Specific Gravity (Aggregate).
5) Sieve Analysis (Aggregate).
6) Compressive Strength Test.

PROPERTIES	BAMBOO
Specific Gravity	0.570 to 0.650
Average Weight	0.620kg/m
Modulus of Elasticity	1.6 to 2.1×106kg/cm^2
Compressive Stress	790 t 860 kg/cm^2
Safe working stress in tension	150 to 340 kg/cm^2
Safe working stress in shear	120 to 170 kg/cm^2
Bond stress	5.5 kg/cm^2

Table 1. Properties of Bamboo

LITERATURE SURVEY

1 "Study on Bamboo as Renforcement in Cement Concrete", Jigar K. Sevalia, Nirav B. Siddhpura. Chetan S. Agrawal, Deep B. Shah, Jai V. Kapadia, Vol. 3. Issue 2. (March-April 2013) pp.1181-1190 International Journal of Engineering Research and Applications.

In this study presents the assessment of the viability of the employ of Bamboo as reinforcement in concrete members. In this research the Bamboo was used as a reinforcing material without any treatment and stirrups.

2.BAMBOO REINFORCED CONCRETE: EXPERIMENTAL INVESTIGATION ON MANGA & DAGDI BAMBOO Saurabh Jayagond, Mr. Sudhanshu Pathak, Mr. Mahesh Tatikonde(april 2020) In this research paper titled "Experimental investigation on behavior of bamboo reinforced concrete member", Arpit Sethia and Vijay Baradiya their work provides bamboo as a potential reinforcement in concrete. From stress-strain curves of bamboo, it can be seen that bamboo possesses low modulus of elasticity compared to steel. So, it cannot prevent cracking of concrete under ultimate load. But from the flexural test of bamboo reinforced beam, it has been seen that using bamboo as reinforcement in concrete can increase the load carrying capacity of beam having the same dimensions. For bamboo reinforced concrete beam, the load carrying capacity increased about 3 times that of plain concrete beam having same dimensions. The maximum deflection of bamboo reinforced concrete beam is about 1.5 that of plain concrete. This thesis concludes that it is possible to use bamboo as reinforcing for masonry structure. Though the tensile strength is about 1/3rd that of steel, this is sufficient for masonry structure and provides a more economical and environment- friendly alternative that is accessible to every section of the society. However, there is still ample scope for research on the subject.

3. Replacement of Steel with Bamboo as Reinforcement Bhosale Mahesh Bhimarao, Dr. Santosh Patil (June 2019) In human civilization the construction industry is an integral part. We know that the cost of any construction project is mainly depending on financial factors such as cost of labours and material [1, 6]. We know that concrete is mostly used construction material which having different advantages like its availability, low cost, fire resistance etc. But it has low tensile strength. For getting tensile strength we provide steel reinforcement

[2]. For load bearing structures the steel reinforced concrete is used [10]. Recently Global warming is the major issue, so the main disadvantage of steel is its production [3]. The cost of steel reinforcement will be increasing in future and the production will be shortening [4]. We know that there are many projects which are working on concept low-cost building because any person from middle class family can construct the building [1]. For that we want to find some alternatives. To tackle this environmental issue, we have to use sustainable material.

4. Centre for Indian Bamboo Resources and Technology (CIBART) India at National Institute of Oceaneography , Goa on 30th Sept- 1st Oct ; 2004. The present author presented a technical paper related to Innovative bamboo products for fisheries sector and coastal areas. In this workshop recommendations related to fisheries gear, packging water transportation and local bamboo resource utilization in fisheries sector have been done.The need of demonstration and improvement in the applications of bamboo for raft and packaging as suggested in the paper, is recommended in the workshop.

5. Evaluation of Bamboo Reinforcements in Structural Concrete Member Ayesha Siddika* , Md. Abdullah Al Mamun and Md. Abu Bakar Siddique In the previous research it is obtained that, tensile strength of bamboo reinforcements is comparable with mild steel

reinforcements. Yu et al. [3] found the values of tensile strength of bamboo vary from between 115 and 309 N/mm2. Agarwal et al. [4] observed a tensile strength of bamboo is 370N/mm2. Tensile strength of mild steel ranged between 250-415 N/mm2 in accordance with their grade. Therefore, bamboo's tensile strength lies in the range of mild steel.

6. A REVIEW ON BAMBOO REINFORCEMENT IN BEAM Chetan Bhatiwal, Prof. U. R. Awari (May 2018) Sanjeev Gill, Dr. Rajiv Kumar, bamboo can use as reinforcement. Bamboo is cheap substitute for steel because bamboo grows much faster and is renewable source after 5- 6 years. Water absorption in bamboo is directly affect the strength of bamboo. Tensile strength of bamboo is good so it can be used as a reinforcement. The behavior of bamboo as a reinforcement is same as plain steel bar [1]. I. K. Khan, it is found that the tensile strength of bamboo is approximately one half of the mild steel. The tensile strength of bamboo is 132 N/mm2 [2].

Bamboo as reinforcement in beam

1. Tension test performed on bamboo strip revealed elastic behaviour and its ultimate strength was 110.05N/mm2
2. The modulus of elasticity of coconut shell concrete was found to be 12070.2N/mm2 which represents 55%, 58%, 44% and 61% that of modulus of elasticity of conventional concrete for IS 456, ACI-318, EU and B 8110 codes resp.

RESULTS

Compressive Strength The compressive strength of the bamboo for specimens having different diameter about 20-25 mm have been analyzed and the collective readings for top, middle and end regions were tabulated. The stress strain behaviors for specimens were considered to obtain the weak zone.

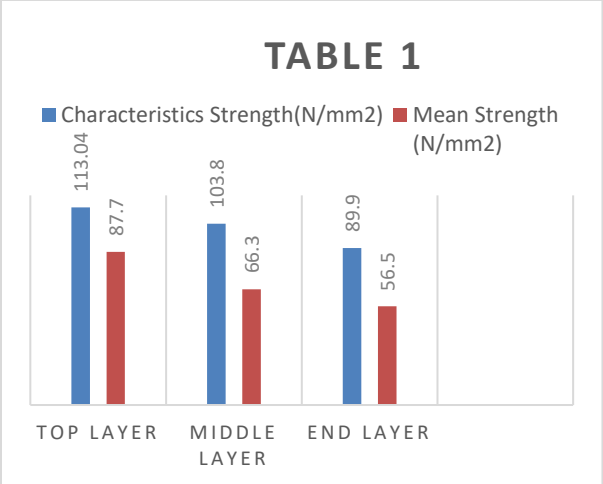

TABLE 1 Compressive Strength Results

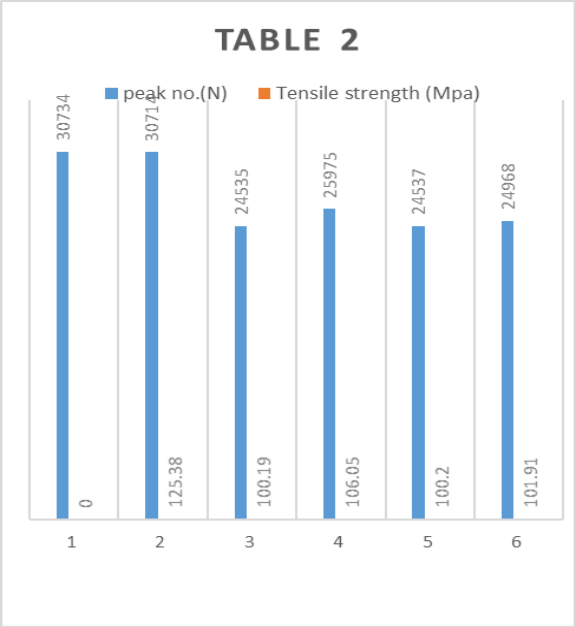

TABLE 2: Tensile Strength Result

CONCLUSION

This study shows the feasibility of using bamboo as a reinforcing material in concrete

Inference form the stress-strain curves shows that bamboo has low elastic modulus compared to that of steel hence it won't prevent the deterioration of concrete under ultimate loading.

1. But from the flexural test of bamboo reinforced beam, it has been seen that using bamboo as reinforcement in concrete can increase the load carrying capacity of beam having the same dimensions.
2. The top layer compression shows 32.2% increase when compared to other layers of compression, this is due to the concentration of bamboo on the top layer.
3. Due to its low elastic modulus, tensile strength of the bamboo shows some greater improvement.
4. The flexural strength of the bamboo reinforced concrete shows 77.7% increase on compare to plain concrete. The strength may be increased mainly due to the presence of natural strong fibers which helps to withstand bending stress.

From all the above conclusions, the bamboo, a natural fibre can be used as a very good reinforcing material in concrete.

REFERENCES

[1] Lakkad; Patel (June 1981). "Mechanical properties of bamboo, a natural composite Fibre Science and Technology 14 (4): 319-322. Doi: 10.1016/0015 0568(81)90023-3.

[2] Landler, Mark (27 March 2002). "Hong Kong Journal;For Raising Skyscrapers, Bamboo Does Nicely". New York Times. Retrieved 12 August 2009.

[3] Nancy Moore Bess; Bibi Wein (1987). Bamboo in Japan. Kodansha International. p. 101. ISBN 4-7700-2510-6.

[4] Cassandra adams. "Bamboo Architecture and Construction with Oscar Hidalgo". Natural Building Colloquium. Retrieved 11 August 2009

[5] Jigar K. Sevalia. Nirav B. Siddhpura. Chetan S. Agrawal. Deep B. Shah, Jai V Kapadia, Study on Bamboo as Reinforcement in Cement Concrete", International Journal of Engineering Research and Applications, Vol. 3. Issue 2, March-April 2013. pp.1181-1190.

[6] Avula Ganesh Reddy, A Joshua Daniel "Study on Behaviour of Bamboo as Reinforcement with Coconut Shell as Aggregate Concrete in Compression Member with Different Lengths, International Journal of Innovative Research in Engineering & Management (IJIREM). Volume-3, Special Issue-1. April-2015

[7] Avesha Syeda. Barvaliya Shrujal Jayesh Kumar, A Case Study on Bamboo as Green Building material. International Journal of Engineering and Advanced Technology (IEAT). Volume-4 Iss-2 December 2014

[8] S.R.Imadi, I.Mahmood, A.G.Kazi, Bamboo fiber processing, properties, & applications, in: Biomass & Bioenergy, Springer, Cham, 2014, pp. 27–46

[9] Z.C. Muda, S. Beddu, A. Syamsir, J.S. Ating, N.L. Kamal, K.N. Mustapha, S. Thiruchelvam, F. Usman, M.A. Alam, A.H. Birima, O.S. Zaroog, Impact resistance behaviour of light weight rice husk concrete with bamboo reinforcement, IOP Conference Series: Earth and Environmental Science, IOP Publishing, 2016. 1,012020.

[10] Khosrow Ghawami, "Bamboo as Reinforcement in Structural Concrete Elements Bamboo", Cement and concrete composites 27 (2005) 637-649.

[11] Masakazu Terai and Koichi Minami, "Fracture Behavior and Mechanical Properties of Bamboo

Reinforced Concrete", Procedia Engineering 10 (2011) 2967-2972.

[12] Adom –Asamoah Mark and Afrifa Owusu Russell, "Comparative study of Bamboo reincforced concrete beams using different stirrup materials for rural construction", International Journal of Civil and Structural Engineering, Volume 2 2011.