ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

AN EXPRIMENTAL COMPARATIVE ANALYSIS OF MODIFIED BAMBOO STRAP REINFORCED CONCRETE BEAMS AND STEEL REINFORCED CONCRETE BEAMS

K.Kantharuban *, Dr. R. Venkata Krishnaiah**

*Research scholar, Department of civil engineering, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073, Tamilnadu, India. Email: rubanunivers@gmail.com

** Professor, School of civil engineering and Infrastructure, Bharath Institute of Higher Education and **Research** (BIHER), Chennai-600073, Tamilnadu, India. Email: venkatapec@gmail.com

ABSTRACT

The present scenario of the world is focused more on sustainability, with part of that in construction industries this research work was focused on Bamboo reinforcement for beam instead of steel bar reinforcement. These trials were taken by more researchers, to be a novelty we focused on ductile and bonding improvement. Most of the cases of steel reinforcement will be more costly and it produces more pollution. The production of steel will create nearly double the time of CO2 emission. Bamboo has elevated potency to weight ratio and easiness in working with undemanding tools. It has an elongated and well-recognized custom as a structure material during the tropical and subtropical regions. It is used in many forms of construction, especially, for housing in rural areas. However, enough attention has not been paid towards research and development in bamboo as a construction material for different uses. In this research, three different methods of reinforcement were taken and tested. Normal bamboo straps, bamboo strap with epoxy coating, bamboo strap with binding wire spiral wounding, and epoxy coated were used and compared with normal steel reinforcement for flexure and deflection and shear reinforcement. By this compression bamboo strap with binding wire spiral winded and epoxy coated beams are given better results.

1. INTRODUCTION

Bamboo is obtainable all over the place about the world; a few areas within the earth persist in the direction of use bamboo construction toward these present days. The liveliness essential to create one cubic meter/ unit of stress predictable during carry out in favor of resources usually old civil building was compared by means of with the intention of bamboo. It was establish to facilitate intended for steel bar it is essential toward use up 1.5 epoch extra power than used for bamboo. During the construction of one tons of steel bar 2 tons of carbon-di-oxide is formed. Within distinction bamboo stand take up carbon-di-oxide as well make oxygen. With the help of literature review tensile strength of bamboo has obtained about 200Mpa to 300MPa; with the result of that the bamboo straps are suggested to use as reinforcement in concrete instead of steel bar reinforcement.

The possible of bamboo straps seeing that an alternate for steel bar reinforcement in toughened concrete beam was deliberate by a lot of researchers (I. K. Khan [1], M. Usha Rani [2], James Kariuki and Richard A. [3], and K. Ghavani [4]). Strength of tensile for bamboo straps reinforcement is more or less the similar with steel bar reinforcement, other than bamboo straps is not as yielding as steel bar. Each and every one individuals investigation consequences demonstrate with the intention of the capability of beam flexure only 60% from the capacity, stipulation the bamboo straps reinforcement in flexure members attain its utmost potency. The low down capability happen for the reason that the bamboo straps and cement concrete was no glowing attached. The current investigate beginning to augment the routine of bamboo strap reinforced beams by winding of binding wire various synthetic resin coating in the reinforcement. This accomplishment is to build up the connection of bamboo straps and cement concrete. As an insubstantial fabric, straps are benefit to employ as light-weight pre-cast construction. The light-weight structure employ intended for pre-cast beam element, will decrease the behavior load carrying. Replacement the normal bar support by means of bamboo straps be the advantage of decrease the self weight. Used for RCC beams, the actual inside pressure area does not need high strength. The concrete be able to restore by means of light mass of building bricks. The present investigate connected with substitute to the strain areas of beam element with light-weight pre-cast brick.

Bamboo Strap reinforced concrete has in addition to use on behalf of top frame structure. Various revise has been completed (S.M. Dewi [5]), the current explore beginning to employ the aggregate of light-weight in existing to decrease heaviness to pre-cast structure, in addition to utilize a few hanger addicted to the dual of Structures.

2. DETAILS OF CONVENTIONAL AND BAMBOO STRAPS BEAMS

Model 1 (M1) as conventional steel reinforcement beam of 12mm diameter bars of 2 at bottom and 2 at top as shown in fig1. Beam model 2 (M2) plain bamboo straps 20mmX10mm average size of 4 at bottom and 3 at top as shown in fig2. Beam Model 3 (M3) straps are coated resin and sprayed with M-Sand 20mmX10mm average size of 4 at bottom and 3 at top as shown in fig3.To improve the ductility of bamboo straps beam model (M4) has 2mm binding wire with 20mm spacing spiral and coated with synthetic resin. After coated resin straps 20mmX10mm average size of 4 at bottom and 3 at top are sprayed with M-Sand to make rough surface, as shown in fig 4.

Fig 1 Model 1 (M1) as conventional steel reinforcement beam

Fig 2 Model 2 (M2) Bamboo straps 20mmX10mm average size of 4 at bottom and 3 at top

Fig 3 Model (M4) has 2mm binding wire with 20mm spacing spiral and coated with synthetic resin

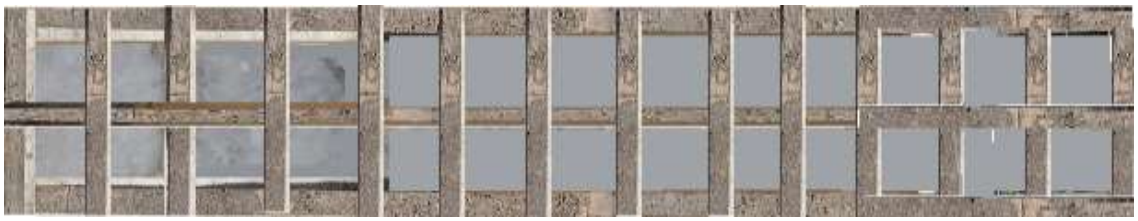


Fig 4 Model 3 (M3) straps are coated resin and sprayed with M-Sand 20mmX10mm

3. PROPERTIES OF BAMBOO STRAPS REINFORCED BEAM

3.1 Perfunctory and Physical properties of bamboo straps

3.1.1 Examination of tensile strength on bamboo straps. The test of tensile was carrying out on the bamboo Straps to discover the critical tensile potency of bamboo straps. Test for tensile strength is essential to make on the bamboo straps to ensure weather conditions bamboo straps be capable of continue the loads of tensile in concrete, as soon as bamboo straps worn as reinforcement in structural component. Entirely 6 bamboo straps were experienced in tensile experiment within 4 bamboo straps contain joint in among and previous 4 bamboo straps with joint at ends. The crucial strength of tensile bamboo straps was established to be 180 N/mm^2 with midpoint nodule and 220 N/mm^2 by means of joint at ends.

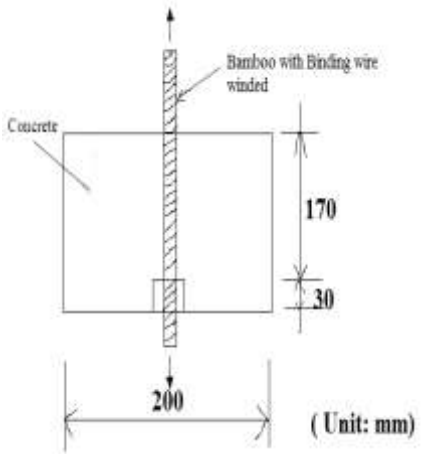


Fig 5 Bamboo Strap winded with binding wire of 2mm spacing in tensile test setup

3.1.2 REINFORCED CEMENT CONCRETE (RC) BEAM-ELEMENT:

Normal bars of yield Fe 415 assessment was chosen for reinforcement RC beam casted the sizes. The details of reinforcement and sizes are given in table 1.

Table1. Propose of Steel Reinforced Beam

Beams Types	Reinforcement beam (Steel Bar)
Size of Beam Used	150 x 150 x 1000 mm
Concrete Grade Used	M30
Steel Grade Used	Fe 415
Constants of Design a) Permissible tension b) Xu-lim	 1.190% 0.48d
% of Reinforcement Provided	1.05%
Provided Steel Reinforcement	4 no. of 12 mm bars
Clear Cover	25mm

3.1.2 Bamboo straps reinforced cement concrete beam:

The bamboo straps were obtained from Kolinchamparai, Pollachi, Tamilnadu. The bamboo straps were equipped intended for approximately 3 weeks and after that were make the most of build up the bamboo straps strengthening concrete beam. Part arrangement decisive factor for beam are not easily reached. Within this technique, province of support given in beam was retained similar the same as to facilitate given in beam element to mutually. The details of bamboo strap reinforcement and sizes are given in table No 2.

Table. 2 Propose of Natural Bamboo strap durable Beam

Type of Beam	Bamboo straps reinforcement beam
Size of Beam Used	150 x 150 x 1000 mm
Concrete Grade Used	M30
Adopted Bamboo	4 Bamboo Straps at bottom and 3 at top
% of Reinforcement Provided	1.8%
Clear Cover	25mm

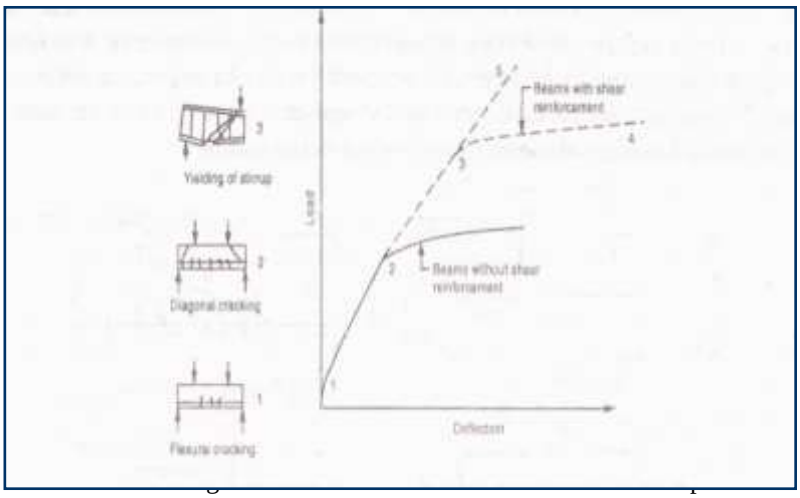
4. RESULTS AND DISCUSSIONS

This project is a new technique in bamboo straps reinforced beams, various set of above mentioned beam has evaluated and experimental test result were obtained

- M1 steel reinforced Beam (SRB)
- M2 Normal Bamboo Straps (NBS)
- M3 Bamboo Straps with Epoxy resin coating (NBSEC)
- M4 Bamboo straps + binding wire winded + M sand sprayed. (BSBW)

4.1.2 BEHAVIOUR OF SHEAR IN STEEL AND BAMBOO STRAPS REINFORCED CONCRETE BEAMS

At what time shear reinforcement is afford, the beam preserve further load till the stage 3 is attain while the shear reinforcement cross the transverse crack capitulate, and huge deflection and too much cracking happen with caution of imminent collapse.



A sum of 16 beams was cast. Out of those twenty beams, four beams were cast as steel reinforced (M1) one and remaining 16 beams are made as bamboo straps and binding wire winded (M2, M3, M4) were used to reading the shear performance. Every beam was experienced for shear and flexure in a loading framework proficiency of (1000 kN) by means of Jack load capability of 500kN. These beams were experienced resting on an effectual length of 1000mm among simply hold up situation in two-point load. Deflection was examined in the load position in addition to middle length by means of LVDTs - Linear Variable Differential Transducers. The split example was in addition record at each load augmentation. Every beam was experienced up to breakdown, the load System of SRB as given in Fig 7.

Fig 7. Arrangement of normal steel reinforcement Beam

The similar testing process has follow for Bamboo strap reinforced beams testing too. The diagram of load system, curve measuring gauge display and LVDT-deflection as shown in the Fig 8.

Fig 8. Arrangement Strain Measurement and LVDT-Deflection

The Failure and the Crack pattern of flexure beam are shown Fig. 10 respectively the specimen model M1 & M4

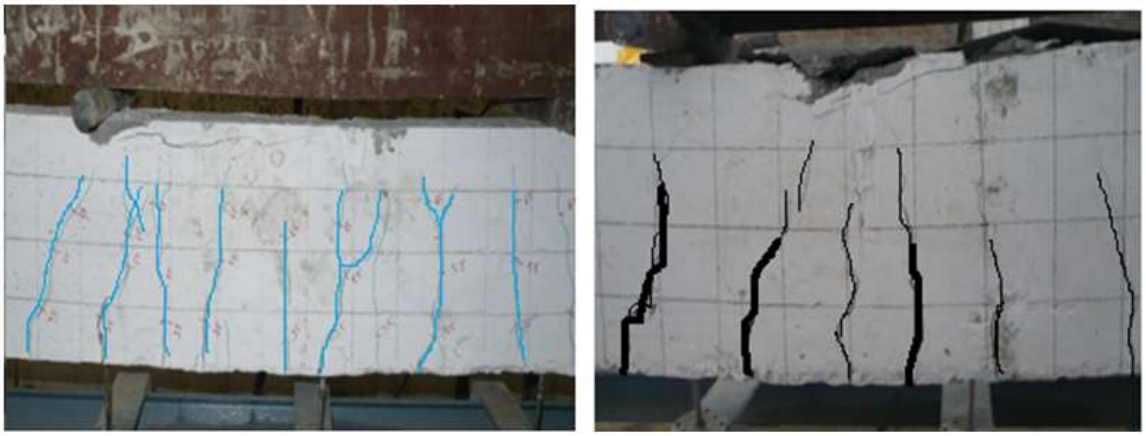


Fig 10. a) M1 Normal Steel Reinforced Beam b) Bamboo Straps with binding wire winded beam

The review of the flexural experiment results are tabulated in Displacement Ductility, Rotation Ductility, Curvature Ductility, Load Ductility Table 3, 4, 5,6

Load Ductility

$$\mu p = P_u / P_y$$

Where,

P_y is the load at which tension steel yields

P_u is the Ultimate load of the beam.

Table3 Displacement Ductility

Beams	Maximum Deformation Δ_u (mm)	First Yield Deformation Δ_y (mm)	Displacement elasticity $\mu = \Delta_u / \Delta_y$
M1	18.32	4.16	4.40
M2	14.28	3.88	3.68
M3	18.59	4.75	3.91
M4	17.87	4.32	4.14

Table4 Rotation Ductility

Beams	Maximum Rotation θ_u (radian)	Primary Yield Rotation θ_y (radian)	Rotation Elasticity $\mu = \theta_u / \theta_y$
M1	0.0269	0.0061	4.410
M2	0.0207	0.00579	3.58
M3	0.0256	0.00676	3.79
M4	0.0255	0.00616	4.140

Table5 Curvature Ductility

Beams	Maximum Curvature φ_u (radian/mm) x 10^{-6}	Curvature at First Yield φ_y(radian/mm)x10^{-6}	Curvature Ductility $\mu = \varphi_u / \varphi_y$
M1	227.68	53.26	4.27
M2	210.36	63.21	3.33
M3	211.42	54.47	3.88
M4	212.86	53.35	3.99

Table6 Load Ductility

Beams	Max Load P_u (kN)	First Yield P_y (kN)	Ductility $\mu = P_u / P_y$
M1	69	45	1.34
M2	47	35	1.4
M3	58	40	1.53
M4	66	45	1.45

The maximum ultimate load carrying capacity of Bamboo straps with wire winded and resin coated with M-sand sprayed beam (BSBW-M4), has 86% of normal steel reinforced were received from the carrying capacity of control beam (M1) in flexure. The deflection of (BSBW-M4) ultimate load is also 1.28 times higher when compared with control beam (M1).

The load deflection bends manifestation how the Bamboo strap with binding wire winded increase the capability and damage of beam element. A standard elongation strain strengthening moreover greater than before as of 40 N/mm2 - 70 N/mm2 attain potency of bamboo straps potency. Disintegrate happening as of fractured on beam tension zone in addition to the numeral split is greater than before, for the future to end with split continues at compression zone.

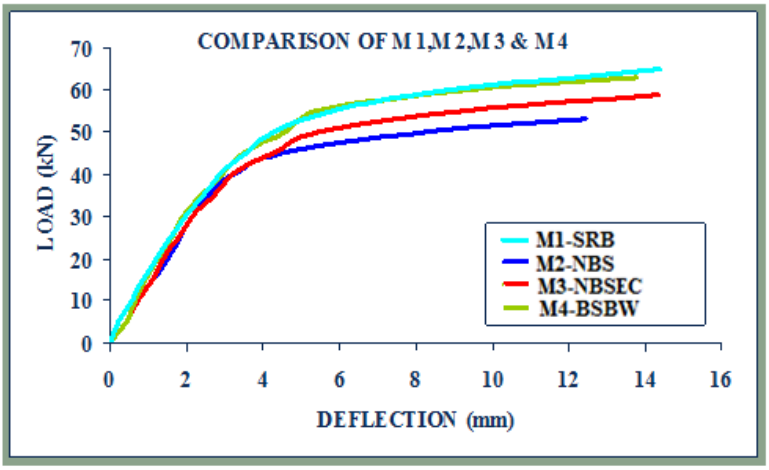


Fig. 10 P-Δ Curve Comparison for M1, M2, M3 & M4

Moment Vs Curvature (M-Φ) curves for M1.M2,M3,M4

Moment Vs bend curves for the specimens were tested for Flexure is shown. Comparison of M&Φ curves for element sample M_1(SRB), M_2(NBS), M_3(NBSEC) & M_4 (BSBW) are shown in fig. 11.

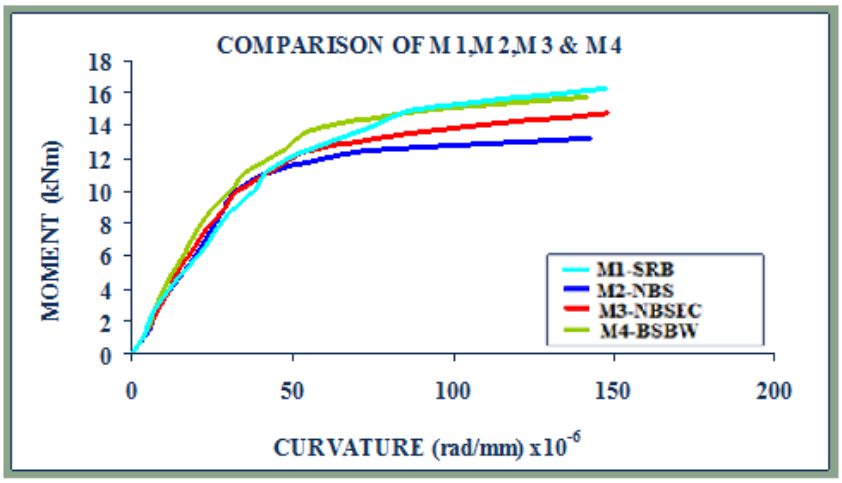


Fig. 11 Comparison of M-Φ Curve for M1,M2,M3 & M4

5. CONCLUSION

- By the utilization of bamboo straps for Eco-friendly construction resources, additional rapidly put into practice and additional assessment in conditions of expenditure and ecological sustainability is extremely motivating to more deliberate.
- The employ of binding wire winding and M-sand spray next to the beam element gifted towards append tension load performance capability strengthening. Additional bamboo straps and binding wire winded with M-sand sprayed (BSBW) reinforcement adjoin add to successful stress of 40 MPa to 70 MPa.
- The maximum ultimate load carrying capacity of Bamboo straps with wire winded and resin coated with M-sand sprayed beam (BSBW-M4), has 86% of normal steel reinforced were received from the carrying capacity of control beam (M1) in flexure. The deflection of (BSBW-M4) ultimate load is also 1.28 times higher when compared with control beam (M1).
- The use of BSBW reinforcement similar to hooks on the steel reinforcement resolve and chance to create an inflexible beam-column connection. An additional category of BSBW was interesting for the next research.
- When we are using insubstantial resources is extremely beneficial in favor of pre-cast construction and seismic-opposing structures. The application of building in addition to manufacturing advantage to Eco-friendly vision.

References

1. K. Ghavani, Bamboo as reinforcement in structural concrete elements, Cement and Concrete Composite, 27, 637-649 (2005).

2. L. Kharee, Performance evaluation of bamboo reinforced concrete beams, Master Thesis, University of Texas, Austin, USA, (2005).

3. M. Terai and K. Minami, Fracture behavior and mechanical properties of bamboo reinforced concrete members, Japan Procedia Engineering,10, 2967-2972 (2011).

4. S.M. Dewi, Bamboo use for earthquake resistance housing, Int. Conf. on Earthquake and Disaster Mitigation, Sepuluh November Institute of Technology, Surabaya, Indonesia, (2011).

5. [5] S.M. Dewi, Roof frame from bamboo concrete composite, J. of Materials Science and Engineering, B-1(1), 113-116 (2011).

6. K. Ghavami. (2008). "Bamboo: Low cost and energy saving construction materials". London: Taylor and Francis Group, 5-21

7. A. Wibowo, I. Wijatmiko, and C. R. Nainggolan, (2017). "Structural Behavior of Lightweigh Bamboo Reinforced Concrete Slab with EPS Infill Panel" AIP Publishing, doi: 10.1063/1.5003507

8. Nindyawati and B. S. Umniati, (2016). "Bond Strength of Bamboo Reinforcement in Light Weight Concrete" Journal of Civil Engineering and Architecture 10: 417-420

9. A. Agarwal, B. Nanda, and D Maity. (2014)."Experimental investigation on chemically treated bamboo reinforced concrete beams and columns" Elsevier Construction and Building Materials 71:610–617

10. H.C. Lima, F.L. Willrich, N.P. Barbosa, M.A. Rosa, and B.S. Cunha, (2007). Mater. Struct. 41, 981

11. M. Yamaguchi, K. Murakami, K. Takeda, (Kyoto, Japan, August 18-21, 2013). "Flexural Performance of Bamboo-Reinforced-Concrete Beams using Bamboo as Main Rebars and Stirrups".3rd International Conference on Sustainable Construction Materials and Technologies, paper E273.

12. A.K. Gupta, R. Ganguly, A.S. Mehra, (2015). Electron. J. Geotech. Eng. 20(6), 1523-1545.