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Investigation on Resisting of Composite Concrete Deep Beam by Bamboo Culm

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Abstract

The aim of this paper is to investigate the sustainability of the composite concrete Bamboo reinforced deep beam under three-point bending analysis. The Bamboo culms have light weight, and they are resistance under the bending test. Despite extending the length of the concrete beam, it behaved perfectly by adding Bamboo culms as reinforcement bars. The composite concrete Bamboo reinforced deep beam is presented the excellent chord rotation which is close to the steel reinforced concrete beam (SRCB). Also, the moment rotation of the CCBRB is same to the (SRCB). That is why Bamboo might be utilized as an alternative to steel reinforcement bars in buildings.

Key words: Bamboo, Concrete, Finite element, composite material.

Introduction

In the current context, the bulk of housebuilding projects are constructed with traditional materials such as steel and concrete, which has expanded over the last decades. The demand for traditional building materials has expanded dramatically. Steel and cement manufacturing has a massive impact on the natural environment caused by the discharge of CO2 and other harmful gases. This is one of the most significant disadvantages of traditional building materials. Since 1960, scientists have been looking for an alternate material. Along with concrete, various naturally occurring fibers were employed. The goal of these ingredients is to improve the mechanical qualities of ordinary concrete. Bamboo is one well naturally occurring substance. Bamboo is a rapidly growing, regenerative, resilient, and environmentally beneficial material. Bamboo absorbs one ton of CO2 from the atmospheric air throughout its growth. Bamboo became one of the most commonly accessible raw materials in the tropical zones where the majority of third-world countries are located [1, 6]. The shape of a conventional bamboo culm is a hollow circular cross section with diaphragms/nodes running the length of the culm. From down to up, the wall thickness, interlayer distance, diameter, and fiber density vary. The bamboo strip has a great tensile capacity according to the

culm's fibrous (along the grain) nature. Bamboo has a high strength-to-weight ratio when compared to standard reinforcing steel (about six times higher). A bamboo culm accomplishes its optimal resilience at three to four years of age, and it grows entirely by fifth year. Because of its strong fibrous structure, it can withstand both tension and compression loading, unlike any other natural material, which can only withstand tension. Furthermore, because bamboo is an organic natural substance, the sustainability of bamboo in a concrete composite has limitations. The use of bamboo in the form of culms or strips within concrete is primarily determined by the strength of the bamboo concrete bond. The bonding of bamboo and concrete is greatly impacted by friction between the concrete and bamboo surfaces, adherence of coating material adhered to the outside bamboo surface, and mechanical interlock. Many researchers have worked to improve each of these criteria during the previous few decades. These treatment processes are intended to strengthen the connection between bamboo and concrete. This includes the application of different glue on the bamboo surface to create the outer surface water resistant [5, 9]. The influence of grooves on the surface of bamboo on binding strength is also investigated. The impact of changing the basic composition of concrete and the influence on durability and eventual collapse are also investigated. The study also aimed to comprehend the stress block characteristics of beams under specific assumptions, and traditional beam theory moment formulas of design codes were employed to determine the ideal bamboo reinforcement percent, stirrup material, and its spacing, among other things. This paper presented the Model of Composite Concrete Bamboo Reinforced Beam (CCBRB) that is sustained by Bamboo culms through the decrease the utilization of Steel components which are not friendly with environment. As well as the creativity of this paper is the extension of the length of the beam, which is suitable for the establishment of widened buildings. Forever simulation of this model is based on Abaqus Software according to the Finite Elements Methods. Furthermore, the simulation model is compared with the verification model and loaded under load displacement.

Simulated Parts of model

The scheme of the concrete composite beam reinforced by Bamboo culms with cross-sections of 300 x 450 mm with a length of 4 m and the longitudinal Bamboo culms by a diameter of Φ30 mm are shown in figure 1.

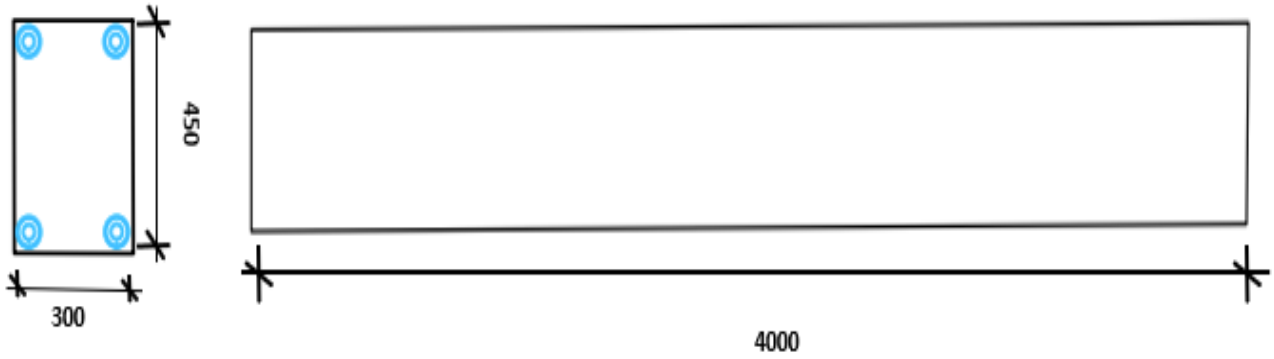

Figure 1: the scheme of the (CCBRB) Model.

Material properties

The material property of concrete is taken from the verified article, which the comprehensive strength of it is 40MAP [16]. As well as the Bamboo reinforcement's mechanical properties are considered [17]. All the properties are shown in table 1.

Table 1: Material properties.

properties	parameter	Inner	Middle	Outer
Bamboo	E_{11} (MPa)	6.51	14.98	21.32
	E_{22} (MPa)	0.273	0.406	0.560
	E_{33} (MPa)	0.273	0.406	0.560
	G_{12} (MPa)	0.096	0.141	0.192
	G_{13} (MPa)	0.096	0.141	0.192
	G_{23} (MPa)	0.096	0.141	0.192
	υ_{12}	0.37	0.34	0.31
	υ_{13}	0.37	0.34	0.31
	υ_{23}	0.37	0.34	0.31
Concrete	C40 (MPa)	-	-	-

Simulation test setup

The CCBRB is simulated based on the verification of the experimental model which is shown in figure 2 [17]. The CCBRB model is analyzed under a three-point bending test based on the verified model which the CCBRB specimen illustrated higher performance despite extending its length. The load-displacement control is used for applying load on the middle point of the beam.

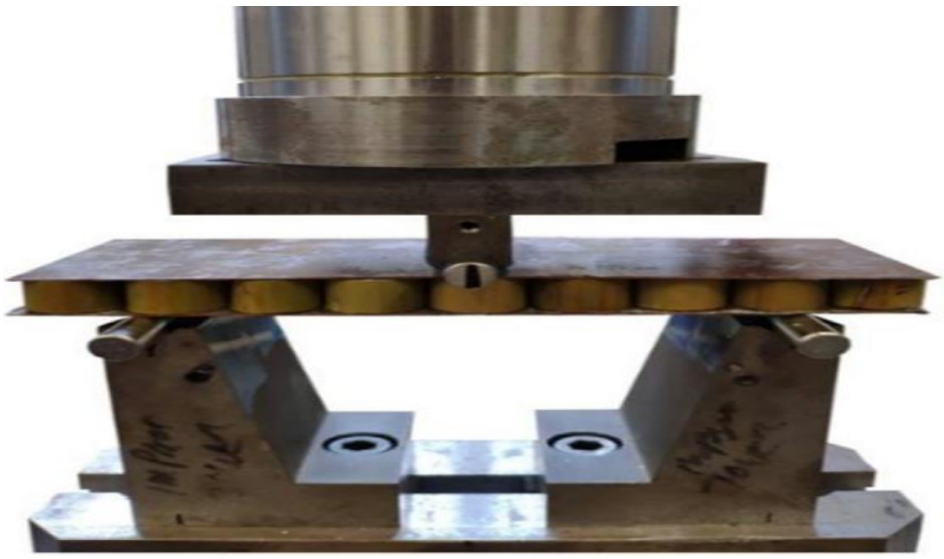

Figure 2: experimental test setup model [17].

Finite Element Method

The Finite element method is utilized for the simulation of the concrete composite with Bamboo under the three-point bending, which is compared with the verification model. The boundary condition and loading point are illustrated in figure 3. Also, the mish type for concrete beams and Bamboo culms is C3D8R which is shown in figure 4.

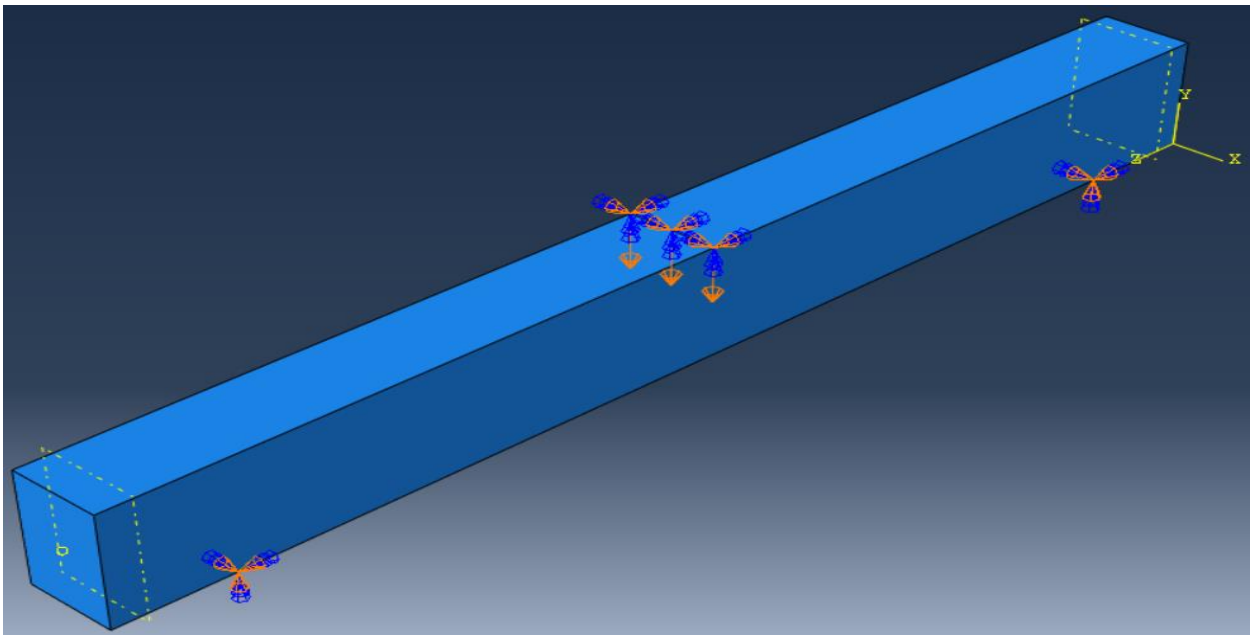

Figure 3: loading and boundary conditions.

Figure 4: mish of the composite concrete and reinforced Bamboo culms model.

Simulation Result

Figure 5 is shown the load and displacement curve that performed better than a verified model because the composite of concrete with Bamboo behaved excellently in bending together. The result of the simulation demonstrated the perfect adjustment between concrete and Bamboo culms.

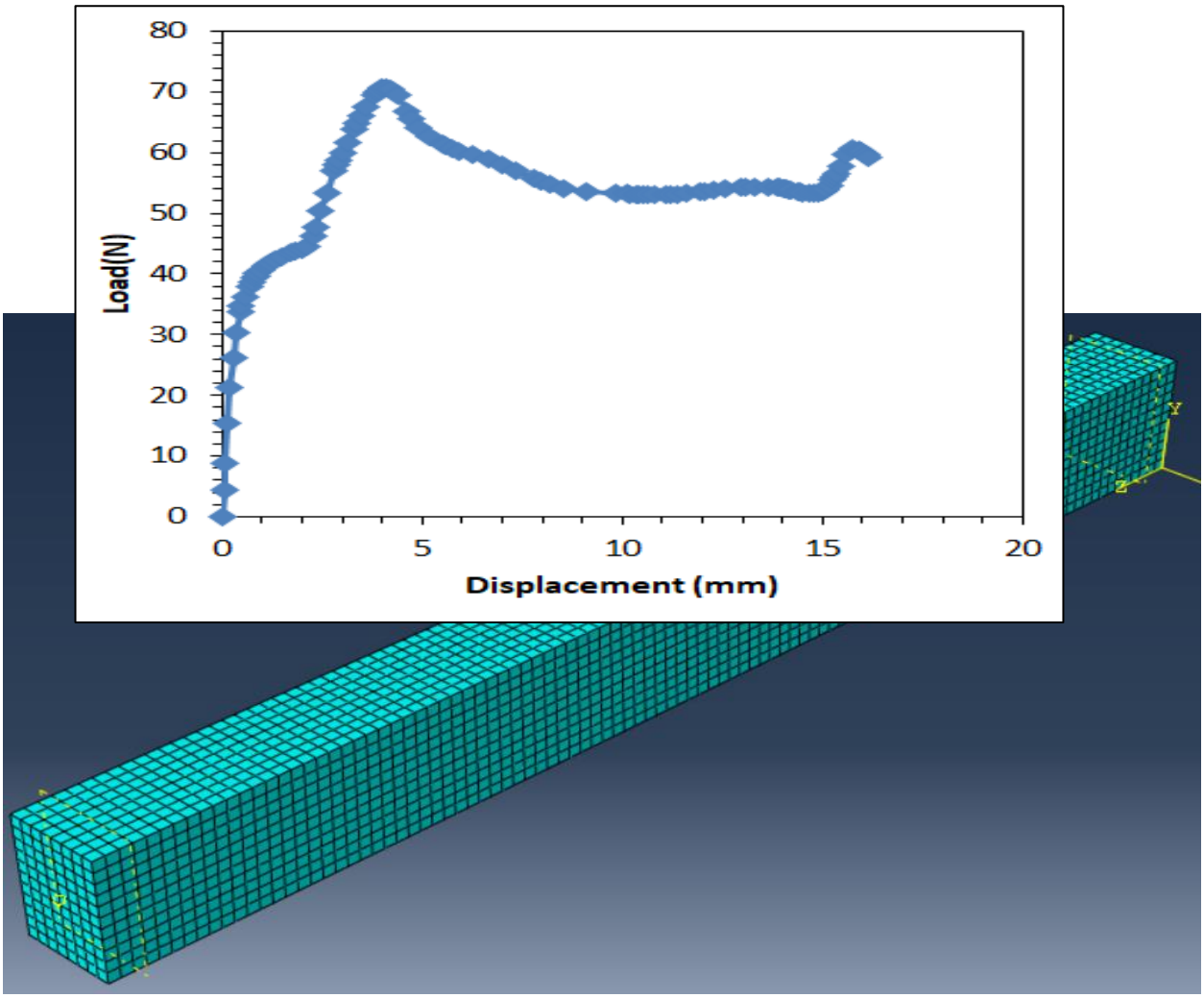

Figure 5: load displacement curve.

Conclusion

The composite concrete deep beam reinforced by Bamboo culms showed more excellent performance than the verified model because Bamboo acted as a good reinforcement component in the concrete deep beam. Despite increasing its length, it behaved perfectly under the three-point bending test. That is why Bamboo might be utilized as an alternative to steel reinforcement bars in buildings.

Reference

[1]. Anandamurthy, A., Guna, V., Ilangovan, M., & Reddy, N. (2017). A review of fibrous reinforcements of concrete. Journal of Reinforced Plastics and Composites, 36(7), 519–552. https://doi.org/10.1177/0731684416685168

[2]. Shan, B., Li, T., Deng, J., Zou, Y., Xiao, Y., Yu, Q., & Zhang, C. (2022). Experimental research on novel RPC-steel composite connections for prefabricated glubam-concrete composite beams. Construction and Building Materials, 333, 127397. https://doi.org/10.1016/j.conbuildmat.2022.127397

[3]. Shan, B., Li, T., Deng, J., Zou, Y., Xiao, Y., Yu, Q., & Zhang, C. (2022). Experimental research on novel RPC-steel composite connections for prefabricated glubam-concrete composite beams. Construction and Building Materials, 333, 127397. https://doi.org/10.1016/j.conbuildmat.2022.127397

[4]. Borowski, P. F. (2022). Management of Energy Enterprises in Zero-Emission Conditions: Bamboo as an Innovative Biomass for the Production of Green Energy by Power Plants. Energies, 15(5), 1928. https://doi.org/10.3390/en15051928

[5]. Alshwely, Z. A., & Naimi, S. (2022). Study Of the Structural Performance of Reinforced Concrete Beam with Hollow Structural and Using Fiber-Reinforced Polymer Composites. *NeuroQuantology*, *20*(16), 2974-2988

[6]. Imadi, S. R., Mahmood, I., & Kazi, A. G. (2014). Bamboo Fiber Processing, Properties, and Applications. Springer International Publishing EBooks, 27–46. https://doi.org/10.1007/978-3-319-07641-6_2

[7]. Borowski, P. F., Patuk, I., & Bandala, E. R. (2022). Innovative Industrial Use of Bamboo as Key “Green” Material. Sustainability, 14(4), 1955. https://doi.org/10.3390/su14041955

[8]. Kumar, D., & Mandal, A. (2022). Review on manufacturing and fundamental aspects of laminated bamboo products for structural applications. Construction and Building Materials, 348, 128691. https://doi.org/10.1016/j.conbuildmat.2022.128691

[9]. Nie, Y., Wei, Y., Zhao, K., Ding, M., & Huang, L. (2022). Compressive performance of bamboo sheet twining tube-confined recycled aggregate concrete columns. Construction and Building Materials, 323, 126544. https://doi.org/10.1016/j.conbuildmat.2022.126544

[10]. Wei, Y., Chen, S., Jiang, J., Zhou, M., & Zhao, K. (2021). Experimental investigation of bamboo-concrete composite beams with threaded reinforcement connections. Journal of Sandwich Structures &Amp; Materials, 24(1), 601–626. https://doi.org/10.1177/10996362211023529

[11]. Nindyawati, Rosalia, D., & Yusron, F. A. (2017). Effect of variations in overlap length and stirrup spacing on flexural capacity of bamboo reinforcement concrete beams. AIP Conference Proceedings. https://doi.org/10.1063/1.5003527

[12]. Dewi, S. M., Wijaya, M. N., & N., C. R. (2017). The use of bamboo fiber in reinforced concrete beam to reduce crack. AIP Conference Proceedings. https://doi.org/10.1063/1.5003486

[13]. Mali, P. R., & Datta, D. (2018). Experimental evaluation of bamboo reinforced concrete slab panels. Construction and Building Materials, 188, 1092–1100. https://doi.org/10.1016/j.conbuildmat.2018.08.162

[14]. Dewi, S. M., Simatupang, R. M., & Waluyohadi, I. (2017). The use of bamboo and autoclaved aerated concrete block to reduce the weight of precast concrete beam. AIP Conference Proceedings. https://doi.org/10.1063/1.5003495

[15]. M. Adom-Asamoah, R. Afrifa Owusu. (2010). A comparative study of Bamboo reinforced concrete beams using different stirrup materials for rural construction. //doi.10. 6088.ipajcse.2011213033

[16]. NEZHAD, Y. D., & NAİMİ, S. (2022). Numerical investigation of precast reinforced concrete beam–to–column joints by replaceable damper. *Journal of Sustainable Construction Materials and Technologies*, *7*(2), 81-87.

[17]. Ávila De Oliveira, L., Coura, G. L. C., PassaiaTonatto, M. L., Panzera, T. H., Placet, V., & Scarpa, F. (2020). A novel sandwich panel made of prepreg flax skins and bamboo core. Composites Part C: Open Access, 3, 100048. https://doi.org/10.1016/j.jcomc.2020.100048