

# Using bamboo as a construction material: A proposal to investigate its structural performance in multi-story buildings and as an internal reinforcement material in road pavements

Khalid Abdel Naser Abdel Rahim

Independent Researcher in Civil Engineering, Email: [khalid.ar@outlook.com](mailto:khalid.ar@outlook.com), Address: Fátima, Portugal

## INTRODUCTION

Bamboo is considered a new construction material which has many compensations. Many researchers have been continuously investigating the durability of using bamboo material in structures. According to researchers, bamboo material is (1) Architectural natural beauty, (2) much cheaper than other construction materials, (3) light in weight, (4) easier to maintain, (5) green eco-friendly material, (6) sustainable, durable and ductile material, (7) has an acceptable rate in resisting earthquakes. However, there are some disadvantages in using bamboo as a construction material. For instance, (1) it has a high-water absorption rate, (2) bamboo are weak in resisting fire, (3) bamboo are subjected to bacterial and fungus attacks and (4) bamboo can lose its strength if not preserved appropriately.

## LITERATURE REVIEW

Many studies have been conducted in Europe and Asia to investigate the mechanical and physical properties of bamboo and its usage in construction. Janssen (1981) stated the usage of bamboo material in building structures. Moreover, McClure (1981) proposed the usage of bamboo as a building material. Furthermore, Janssen (1987) studied the usage of bamboo material as a reinforcement in structures. In addition, Jagadeesh and Ganapathy (1996) discussed the further research need of traditional bamboo-based walling/flooring systems in buildings. Also, Janssen (2000) explored methods in designing and building with bamboo material. On the other hand, Chung and Yu (2001) studied the usage of structural bamboo and its mechanical properties in bamboo scaffoldings. Furthermore, Lugt et al. (2006) discussed an environmental, economic and practical assessment of bamboo as a building material for supporting structures. Moreover, Gottron et al. (2014) researched the creep behavior of bamboo. Additionally, Li et al. (2017) investigated the axial load behavior of structural bamboo filled with concrete and cement mortar. Besides, Ribeiro et al. (2017) investigated the bending strength and nondestructive evaluation of structural bamboo. Never the less, Singh et al. (2019) made an evaluation of mechanical properties of different bamboo species for structural applications. Conversely, Stephen et al. (2020) analyzed the structural behavior of concrete filled bamboo columns under axial loads. Moreover, Yadav and Mathur (2021) made a review of bamboo as a sustainable material in the construction industry. Also, Drury et al. (2023) investigated an assessment of the compression properties of different giant bamboo species for sustainable construction.

## DISCUSSION

There are many types of bamboo and they vary in many different aspects. For example as shown in Figure 1, (1) different diameters, (2) various hollowness dimensions, (3) some bamboos are completely solid without hollowness, (4) diverse in outer skin thickness. These aspects have different structural behavior when used in construction. Moreover, the current studies have proposed many ways in using bamboo in construction. Some studies proposed using bamboo as an internal reinforcement material embedded in concrete instead of steel bars. While others researched the structural behavior of concrete filled hollow bamboos. The majority of the investigations which has been carried out focused on the structural performance of bamboo as a single structural member. Never the less, none of the current researches proposed investigating the structural performance of bamboo material in multi-story buildings. Neither any of the current researches proposed the usage of bamboo material as an internal

reinforcement embedded in concrete for road pavements. Hence, the objective of this poster is to propose further studies to find the effectiveness and structural performance of using bamboo as a construction material in multi-story buildings and as an internal reinforcement material in pavements.

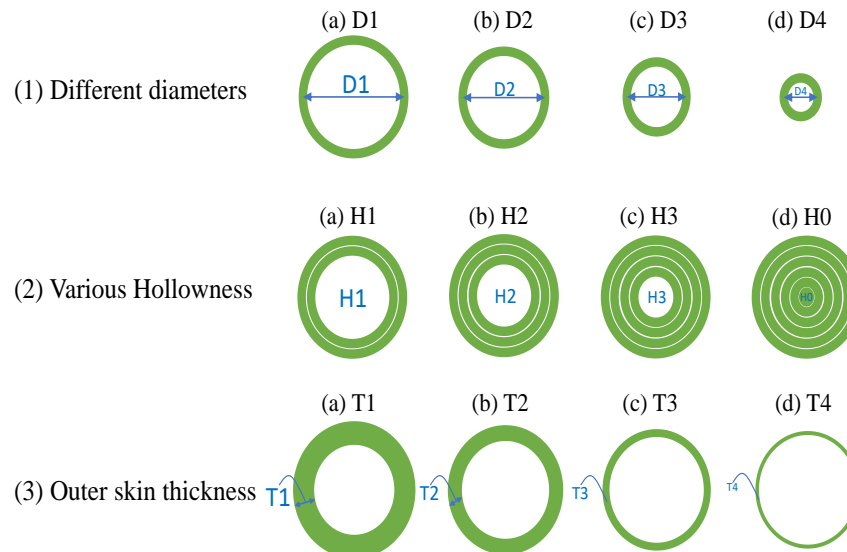


Figure 1: Illustration of variation between bamboo physical properties.

## CONCLUSION AND PROPOSAL

It is strongly believed, that essential outcomes will be explored when studying the structural behavior of bamboo material in multi-story buildings in real life projects as demonstrated in Figure 2. Because as a rule analyzing single structural elements will always have many missing outcomes and misunderstanding on the complete performance of the bamboo structural performance. In addition, the author of this poster assumes that there are great benefits from replacing typical steel rebars with bamboo material as an internal embedded reinforcement inside concrete road pavements as shown in Figure 3. Advantages many include lower cost and greater structural resistance against various loads.

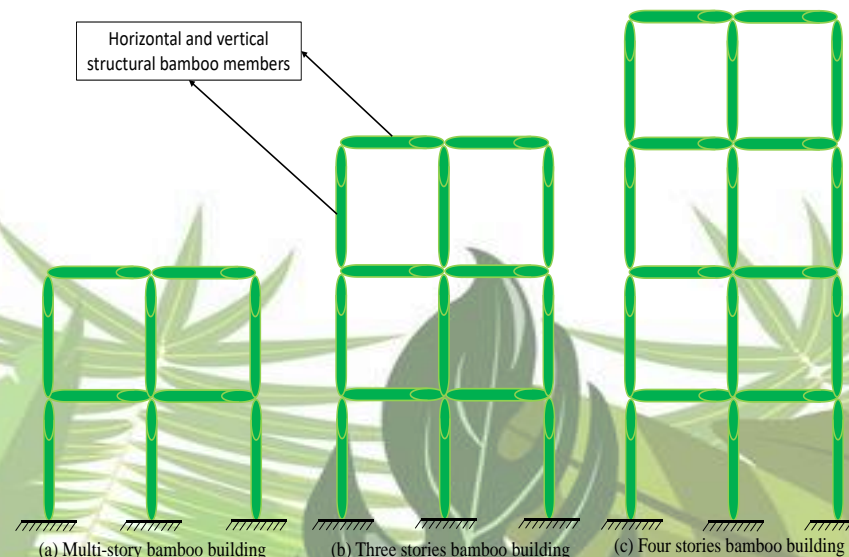


Figure 2: Multi-stories bamboo structural building.

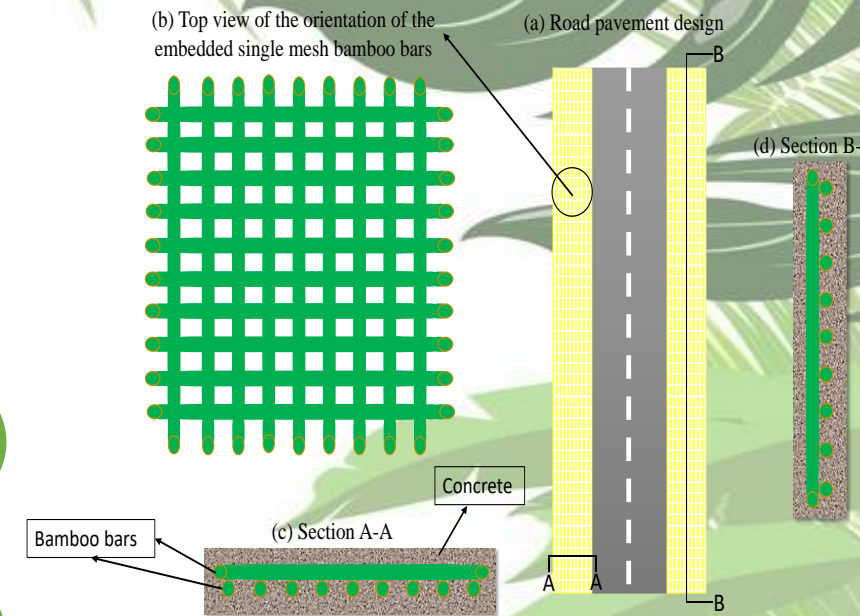


Figure 3: Design of embedded internal bamboo reinforcement in road pavements.

## REFERENCES

- Chung, K.; Yu, W. (2001) *Mechanical properties of structural bamboo for bamboo scaffoldings*. *Engineering Structures*, 24, 429–442.
- Drury, B.; Padfield, C.; Russo, M.; Swygart, L.; Spalton, O.; Froggatt, S.; Mofidi, A. (2023) *Assessment of the Compression Properties of Different Giant Bamboo Species for Sustainable Construction*. *Sustainability*, 15, 6472.
- Gottron, J.; Harries, K.A.; Xu, Q. (2014) *Creep behaviour of bamboo*. *Construction and Building Materials*, 66, 79–88.
- Jagadeesh, H.N.; Ganapathy P.M. (1996) *Traditional bamboo-based walling/flooring systems in buildings and research needs*. In Ganapathy, P.M.; Janssen, J.A.; Sastry, C.B. ed., *Bamboo, people and the environment*, Vol. 3, Engineering and utilization. Proceedings of the Vth International Bamboo Workshop, Ubud, Bali, Indonesia, 19-22 June 1995. International Network for Bamboo and Rattan, New Delhi, India, pp.20-32.
- Janssen, J.J.A. (1981) *Bamboo in building structures*. Ph.D. thesis at the Technical University of Eindhoven, The Netherlands. 234 pp.
- Janssen, J.J.A. (2000) *Designing and building with bamboo*. Technical report No. 20, Technical University of Eindhoven, Eindhoven, The Netherlands, ISBN 81-86247-46-7.
- Janssen, J.J.A. (1987) *Using bamboo as a reinforcement*. *Appropriate Technology*, 14(2), 12-13.
- Li, W.-T.; Long, Y.-L.; Huang, J.; Lin, Y. (2017) *Axial load behavior of structural bamboo filled with concrete and cement mortar*. *Construction and Building Materials*, 148, 273–287.
- Lugt, P. V., van den Dobbelen, A.A.J.F., Janssen, J.J.A. (2006) *An environmental, economic and practical assessment of bamboo as a building material for supporting structures*, *Construction and Building Materials* 20 (9) : 648-656, DOI: [10.1016/j.conbuildmat.2005.02.023](https://doi.org/10.1016/j.conbuildmat.2005.02.023).
- McClure, F.A. (1981) *Bamboo as a Building Material*. *Peace Corps. Appropriate Technologies for Development*. Reprint-33.
- Ribeiro, R.A.S.; Ribeiro, M.G.S.; Miranda, I.P. (2017) *Bending strength and nondestructive evaluation of structural bamboo*. *Construction and Building Materials*, 146, 38–42.
- Singh, K.; Garg, H.; Pabla, B.S. (2019) *Evaluation of mechanical properties of different bamboo species for structural applications*. *International Journal of Innovative Technology and Exploring Engineering*, 8, 2927–2935.
- Stephen, S.; Bernadette, S.; Bruce, K. (2020) *Structural Behavior of Concrete Filled Bamboo Columns under Axial Loads*. *Civil and Environmental Research*, 12, 62–67.
- Yadav, M.; Mathur, A. (2021) *Bamboo as a sustainable material in the construction industry: An overview*. *Materials Today: Proceedings* 43, pp. 2872-2876.