Waste Polyethylene Terephthalate Plastic Bottles and Bambusa Blumeana (Thorny Bamboo) as Raw Materials for Scaffold Plank for Construction Platform

Charlies Dave S. Bañez[1], Jeperson A. Faraon[1], Zane I. Flora[1], Camille A. Santelises[1], Jhun M. Jacinto[1]
[1]*School of Engineering, Aurora State College of Technology, Brgy. Zabali, Baler, Aurora, Philippines*
Corresponding Author: charliesdsbanez@gmail.com

***Abstract*: This study investigates the utilization of waste Polyethylene Terephthalate plastic bottles and Bambusa Blumeana (thorny bamboo) as a raw material and treated by seawater for scaffold planks for construction platforms. The research aims to produce a load-bearing scaffold plank that can be used as alternative construction materials while addressing environmental concerns by reusing byproducts. Four material designs were formulated with varying thickness of planks and layers of plastic bottles and bamboo. It is tested for flexural strength (kN-mm) and deflection capacity (mm). Results revealed that 328.25 kN-mm and 58 mm for sample 1, 395.688 kN-mm and 74 mm for sample 2, 446.649 kN-mm for sample 3, and 644.719 kN-mm and 85 mm for sample 4. Each specimen deflected more than the scaffold plank's permitted deflection. The scaffolding plank was not cost-effective to use when compared to coco lumber, which is commonly used for scaffolding and costs ₱120. Samples 1, 2, 3, and 4 of the scaffolding utilized in this investigation cost ₱103.40, ₱1816.70, ₱2546.80, and ₱3731.60, respectively. The study concluded that the treatment and additives for bamboo and PET Plastic to improve service and durability, and cost analysis of Bambusa blumeana and Polyethylene Terephthalate scaffolding board construction, required for further study.**

***Keywords*: Scaffold plank, Bambusa blumeana, Plastic bottles, PET, PVAc-D3.**

1. Introduction

Humanity's increasing consumption and product development lead to increased waste and environmental issues, particularly in the production and consumption of plastics, which pose a threat to human health and the environment. Over 8.3 billion metric tons have already been produced worldwide up to this point [1]. Recycling is crucial for reducing plastic's environmental impact, but industrial production limits its use. Plastic has also been used in civil engineering applications, such as concrete additives and waste binder.

This study explores using plastic bottles and bamboo as raw materials for scaffold planks, a sustainable alternative to traditional wood, to reduce waste plastics [2]. Bamboo, also known as engineered bamboo, is a valuable and superior substitute for wood composites like pulp, paper, stripboards, and plywood.

Dendrocalamus Asper and *Bambusa Blumeana* are considered engineered bamboo due to their structural capacity. This study aims to create a scaffold plank using waste plastic bottles and *Bambusa blumeana*, a common Southeast Asian bamboo with a spine or thorns, as an engineered material, to enhance the construction process [3], [4].

This study investigates the feasibility of PET plastic bottles and *Bambusa blumeana* as scaffold planks, focusing on recycled material and bamboo's load-bearing potential. Scaffolding is a temporary framework used in building and maintenance tasks, providing a safe and accessible support for workers and supplies [5]. Through this, the completion of this study is expected to produce a scaffold plank made of plastic bottles and *B. blumena* that can be used as construction material.

A. Statement of the Problem

This study investigates the feasibility of utilizing plastic bottles and bamboo as a potential scaffold plank. Specifically, the study addresses the following objectives:

The study explores the use of plastic bottles and bamboo as scaffold planks, evaluating their physical properties and mechanical properties. It aims to determine the optimal ratio of bamboo and plastic bottles for desired strength and compares the cost-effectiveness of the combined planks, promoting the reuse of waste products

B. Scope and Limitation

This study investigates the *Polyethylene terephthalate* (PET) and *Bambusa blumeana* (*Thorny Bamboo*) as potential raw material to produce a scaffold plank for a construction platform.

1. What are the mechanical and Physical Properties that affect the construction of scaffold plank?
2. What is the ratio of Bambusa Blumeana and plastic bottles to satisfy the desired strength of the scaffold plank?
3. What is the material and production cost of scaffold plank compared to commercialized plank?

C. *Framework of the Study*

This section shows the concept that outlines the process of developing this study. To conduct this study, it will start with gathering materials such as Bamboo (*Bambusa Blumeana*), plastic bottles, and wood glue. These are the primary materials that are needed to construct a scaffold plank following the required design ratio in the fabrication of sample specimen. Sequentially, the process of determining the results of the study will be based on field experimentation, laboratory testing using flexural testing machines, and analysis of data. And the expected result of this study is the possible fabrication of scaffold plank for construction platforms made of plastic bottles and bamboo.

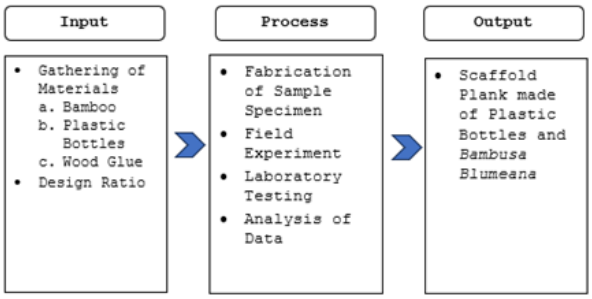

Fig. 1. Conceptual Framework of the study

2. Review of Related Literature

This chapter includes all the results and findings from past studies and articles that are related to the present study, which focuses on the utilization of plastic bottles and bamboo as material used in scaffold planks.

A. *Environmental Effects of Plastics*

The studies revealed that plastic waste is not biodegradable and can persist in the environment for years, highlighting the need for further research.[7]. The study aims to find a sustainable solution for handling, processing, and disposing of used plastic containers, as they pose severe environmental issues and release harmful chemicals.[9], [10]. One of the main causes of air pollution is the open-field incineration of plastic garbage [11]. Plastic, containing harmful chemicals like BPA, thalates, antiminitroxide, brominated flame retardants, and poly-fluorinated compounds, can cause greenhouse gases, clog canals, increase flooding, and harm land and marine animals. [13], [14]

B. *Plastic bottles, Bambusa blumeana, and Polyvinyl Acetate D3 as Construction Materials*

1) *Polyethylene Terephthalate (PET) as an Adhesive to Construction Materials*

Plastic waste in civil engineering applications can reduce waste disposal and improve concrete's mechanical properties. Recycling and utilizing waste plastics can reduce material usage, cost, and quality, while maintaining or improving the properties of the materials used [17]. Plastic bottles are used as adhesives in concrete to enhance compressibility, tensile strength, and load-bearing capacity. They also minimize road cracking and are eco-friendly, as they don't require steel mesh, reducing landfill waste [15] [16] [17].

2) *Bambusa Blumeana as A Substitution for Wood Materials*

The studies reveal that Bambusa blumeana exhibits characteristic strength levels, including compressive and tensile strengths of 20 and 95 MPa, shear strength of 5 MPa, and bending strength of 34.6 MPa and the mean and fifth percentile modulus of elasticity of 13100 and 8600 MPa, respectively [18]

3) *Polyvinyl Acetate D3 Super Wood Glue as an Adhesive in Construction*

D3 glues are reliable for wood assembly due to their water, thermal, and sustained load resistance properties. Polyvinyl Acetate, a water-based solution polymer, is commonly used in furniture, doors, windows, and tiles for its odorless and nonflammable properties. [19]. The study found that adding 1% of Silicon Dioxide nanoparticles to Polyvinyl Acetate adhesive significantly improved its mechanical properties (13.46%–23.88%) [20].

Table 1
Treatment and curing for bambusa blumeana

Treatment	Curing	Citation
Soaking the bamboos to the seawater for seven days.	sun-dried for two weeks lateral drying method	[22], [23],[24]
bamboos are placed running water for 3 months	bamboos were then exposed into smoke for 15 days	[25], [26]
bamboo fibers are soaked in 100°C distilled water for 1 hour the fibers were then soaked in the Sodium hydroxide Solution (5% with heat to 60-65°C)	soaked bamboo fibers in distilled water were then for the same temperature for 40 minutes After soaking with the solution, the fibers are dried with 100°C	[27]
Bamboo strips were soaked in a 5% boric acid solution	The moisture content of bamboo strips reached around 12% after three days of drying at 60°C and 40% relative humidity, then conditioned at 20±2 °C and 65 ±5% relative humidity.	[28]

C. *Treatment and Curing for Bambusa Blumeana*

Bamboo treatment enhances durability and mechanical properties by removing sugar content and carbohydrates that attract fungi and insects, thereby extending the life of the bamboo structure. [21].

D. *Research Gap*

Studies show various methods to minimize waste plastic in the environment, including creating boards with adhesives like epoxy, resins, and bio binders. Waste plastics and Bambusa blumeana can be beneficial for construction, as plastic bottles can act as adhesives. However, studies do not show that plastic bottles can be load-bearing objects.

Table 2
Research gaps

No.	Research Gaps	References
1	Emission of Greenhouse gases	[29], [30], [31]
2	Carrying Significant Dynamic Load of a person/persons	[32]
3	Resistance to crack and fracture under the sudden and intense impact	[33], [34]
4	Ability to withstand applied load	[35], [36], [37]
5	Resistance to Deformation	[38]

The review of articles suggests that waste Polyethylene terephthalate plastic bottles and Bambusa blumeana could be used as scaffold planks for construction platforms, with Bambusa blumeana having high mechanical properties and PET plastic bottles potentially increasing their properties when added to concrete.

3. Methodology

This study uses quantitative research which uses variables to determine numerical values and uses statistical analysis for the values. The research method used is experimental research to measure the potential of Polyethylene Terephthalate plastic bottles and *Bambusa blumeana* as a scaffold plank. In this study, researchers were able to control the variables and modify which are the dependent variables specifically that affect the result of the independent variables. This study also used comparative research, where the comparison of similarities and differences among the variables used a statistical approach to those values.

The experimental process followed the research procedures:

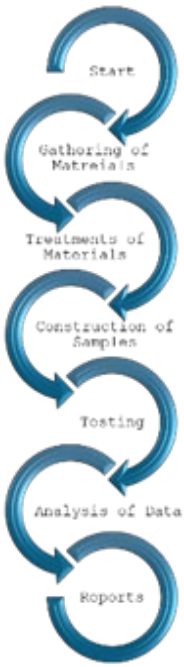

Fig. 2. Research design flowchart

A. Collecting and Specimen Construction

- *For Plastic Bottles (Polyethylene Terephthalate)*

1) STEP 1: Collection of Materials

Fig. 3. Collecting plastic bottles

2) STEP 2: Removing Hard Parts of the Bottles

Fig. 4. Cutting off the neck and bottom part of the bottle

3) STEP 3: Cutting the Remaining Parts of the Bottle into Vertical Strips

Fig. 5. Cutting the PET in vertical strips

4) STEP 4: Weaving the Strips

Fig. 6. Weaving of PET strips

- *For Bamboo (Bambusa Blumeana)*

1) STEP 1: Collection of kawayang tinik from nearby sources

Fig. 7. Gathering bamboo

2) STEP 2: Weighing the Weight After Cutting for the Data of Moisture Content

Fig. 8. Weighing the bamboo

3) STEP 3: Soaking the Bamboo to Seawater for Seven Days

Fig. 9. Seawater treatment for bamboo

4) STEP 4: Treated Bamboo is Sun-Dried for Two Weeks in a Lateral Drying Method

Fig. 10. Sun-drying the bamboo

5) STEP 5: Turning into the Strip 1-Inch Wide, the Thickness Varies

Fig. 11. Cutting into strips

- *For the Construction of Scaffold Plank*

1) STEP 1: Construct a Specimen Based on the Layers of Plastic Bottles and Bamboo

Fig. 12. Constructing specimen

2) STEP 2: Using a Clamp to Hold Layers in Place of the Raw Scaffold Plank

Fig. 13. Fastening the plank

3) STEP 3: Three Hours Compressed Drying

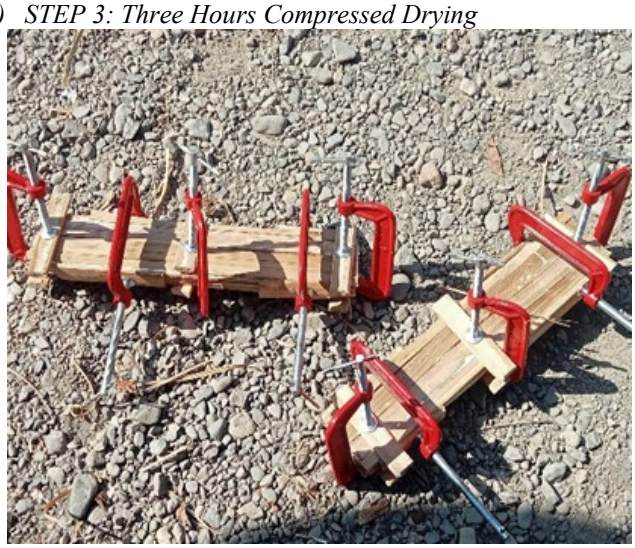

Fig. 14. Compressed drying

B. Material Requirements

The following is the tabulated list of materials necessary in producing scaffold planks. *Polyethene Teraphthalate* is a lightweight substance that is used in carbonated drink bottles made of plastic. *B. Blumeana* was cut at an advanced age and identified by its dark green hue and heavy lichen cover. The glue, PVAc-D3, is water-based, with a pH of 2.7–3–7. It requires two hours of pressing in a chilly setting to cure.

C. Material Design

The ratio of Bamboo must be greater than the ratio of plastic bottle base to their properties where PET plastic bottles having tensile strength 48.3 Mpa – 72.4 MPa [39] and bamboo having 42.2 MPa [18], thus first and last layer use bamboo. These ratios vary in two different samples that depend on thickness which are 25 mm and 50 mm which is the minimum and maximum thickness of scaffold plank based on the book of Occupational Safety and Health Administration.

Table 3
Specimen details

Dimesion Of Scaffold Plank						
Sample	**Layer**	**Thickness (mm)**			**Length (mm)**	**Base (mm)**
1	3	5	Bambusa blumeana	25	400	75
	2	5	PET Plastic			
2	4	5	Bambusa blumeana	25	400	75
	1	5	PET Plastic			
3	3	10	Bambusa blumeana	50	400	75
	2	10	PET Plastic			
4	4	10	Bambusa blumeana	50	400	75
	1	10	PET Plastic			

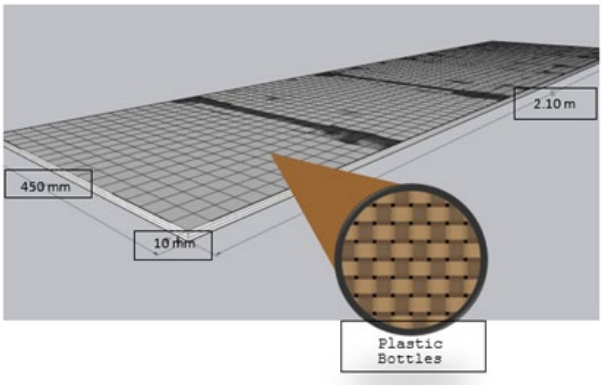

Fig. 15. Single layer model of PET plastic bottles weave in plain pattern

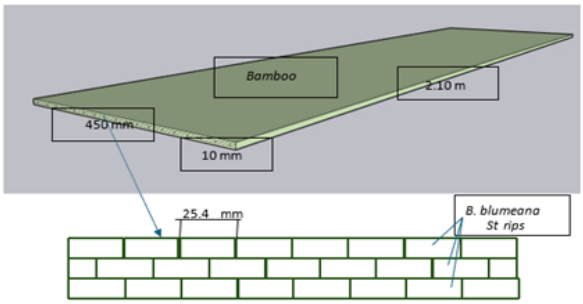

Fig. 16. Sigle layer strips of bamboo

D. Specimen Details

Polyethene Terephthalate (PET) Plastic bottles and Bambusa blumeana are provided and have the same dimensions when it comes to length and width, 762 mm x 152 mm, respectively. The thickness varies between 25 mm and 50 mm, which is the base height of the thickness of the five layers of the scaffold plank. Table 4 shows the details of specimen samples used to determine data that researchers will use in determining the results of this study.

E. Laboratory/Experiment/Field Experiment

1. Compressive Strength Test
2. Displacement of Plank
3. Moisture Content Test

These three testing procedures provide data that will be used in evaluating the load-bearing capacity of the scaffold plank as well as the displacement that will occur from different magnitudes of load applied in the different treatments. Also, the compressive strength of the potential plank will be determined at the laboratory testing.

The findings from the systematic analysis of compression strength, displacement, and moisture content provide evidence-based results in the feasibility of using PET plastic bottles and bamboo as scaffold planks.

F. Research Instrument Used

First, this study uses a camera for documentation of the study and AutoCAD and Sketchup for generating models of scaffold plank and its layers. The researchers observed in this study the load-bearing capacity of the potential scaffold plank. The researchers will input the data on the observation sheet of the researchers. By observation, the researchers will know how high the load the potential scaffold plank can bear. The second thing that needs to be observed is the deflection. Through observation, the researchers will find out how high the potential scaffold plank will deflect as the load is being applied. Concluding data used a graphical method where it shows the result of the synthesized data.

This study also uses Microsoft Excel for the encoding and analysis of the data collected. These data are presented in a bar and line graph. Three sample specimens for each sample group were tested.

4. Results and Discussion

1) Compression Test of Scaffold Plank

Using YE-2000C compression machine, the compression test of specimen of scaffold plank was conducted accordingly. The load was applied gradually to determine the maximum strength capacity of the plank.

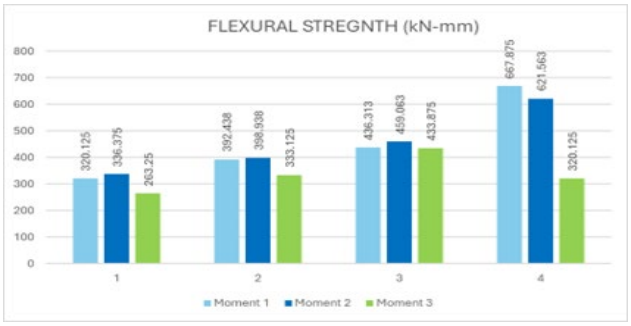

Fig. 17. Flexural strength test result

Figure 15 shows the flexural strength results that were gathered after the testing using the YE-2000C compressing machine. The tested samples (1-4) produced various point loads. Using the maximum moment formula, where the point load (kN) is multiplied by the span of 325 mm and divided by 4, produced the value of the moment: Sample 1 (320.125 kN, 336.375 kN, and 263.250 kN-mm); Sample 2 (392.438 kN, 398.938 kN, and 333.125kN-mm); Sample 3 (436.313 kN, 459.063 kN, 433.875 kN-mm); and Sample 4 (667.875 kN, 621.563 kN, and 320.125kN-mm).

2) Displacement of planks

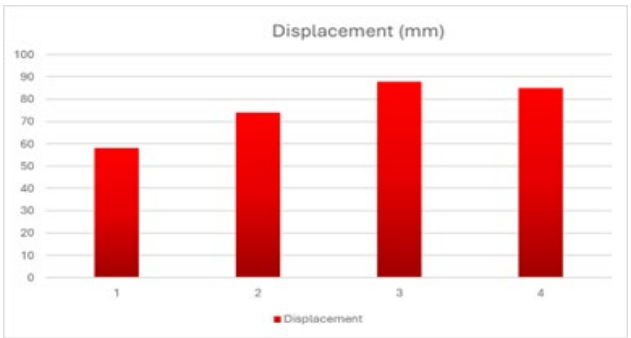

Fig. 18. Displacement test result

Figure 16 shows the displacement result from applying loads. The value measured on initial position of bottom of the sample until the last location of the sample. Governing loads on each sample are used to determine the values for the average deflection. The data for sample 1 (57mm and 59mm), sample 2 (74 and 74), sample 3 (92 and 84), and sample 4 (86 and 84) produced the average deflection of 58mm, 74mm, 88mm, and 85mm.

3) Moisture Content Test Result

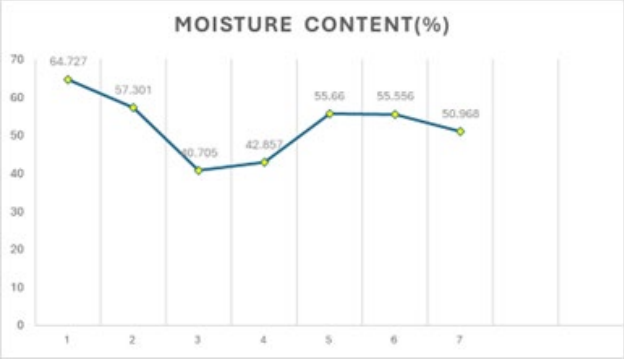

Fig. 19. Moisture content test result

The result in Figure 17 shows moisture content; the values are determined by cutting every 2.33 meters (7 feet) of Bambusa blumeana and splitting it in half and weighing it on a weighing scale after submerging it in salt water for seven (7) days, giving saturated unit weight, and sun-drying it for two (2) weeks or fourteen (14) days, giving dried unit weight. Using the given formula for the mean, the total value of moisture content is then divided by the total amount of moisture content, showing 52.539% moisture content.

4) Cost Analysis

Table 5 is the total cost for each of the layers of the construction of the scaffold plank. The total cost for the construction of the B. blumeana is ₱316.00, from the cutting of the bamboo for ₱50.00 each bamboo and turning into strips for ₱50.00 per strip. PVAc-D3 Pioneer Wood Glue 500g is ₱116.00 per bottle, but only half a gram can be applied on both sides of the bamboo plank. Polyethylene terephthalate (PET) plastic bottle with cap ₱0.09 per bottle PET Plastic Bottles and 30 pcs. of bottles are weaved to complete the span of scaffold plank costing ₱2.70 pesos.

The labor cost is extracted from the cost of materials because labor is a general cost that can be added to the total cost of the construction of a single sample. Example: at Table 6, using sample 1, material cost for one layer B. blumeana plank ₱316.00 multiplied by the number of layers in each sample, the total is ₱948.00, and for the weave PET plastic bottles, the single layer costs ₱2.70, and by multiplying by the number of layers, which are 2 layers, the weave PET plastic bottles cost ₱5.40. The sum of the total value of B. blumeana (₱948.00) and PET Plastic Bottles (₱5.40), the total cost for a single scaffold plank is without labor and equipment is ₱953.40. From ₱953.4 plus the labor (₱100.00) and equipment (₱450.00), the price of sample 1 is ₱1503.4, sample 2 is ₱1816.7, sample 3 is ₱2456.8, and sample 4 is ₱3731.60 pesos.

Table 4
Production cost per layer

MATERIAL COST and LABOR COST of a SINGLE LAYER			
Material	Quantity	Price (₱)	₱
Cost of Single Layer of B. blumeana			
Stalk of B. blumeana	1	50	50
Strip of B. blumeana	3	50	150
PVAc-D3 Glue	0.5	232	116
Total Cost			316
Cost of Single Layer of PET Plastic			
Polyethylene terephthalate (PET) plastic bottle with cap	30	0.09	2.70
Total Cost			2.70
Labor			
B. blumeana (per stalk)	1	50.00	50.00
Plastic (per sample)	1	50.00	50.00
Total Cost			100.00
Equipment			
G-clamp	30	60.00	1800.00
Total Cost			1800.00

Table 5
Unit cost per scaffold plank

SAMPLE	Layer	Material	₱	QTY x ₱	TOTAL	Labor	Clamp	Price
				TOTAL COST				
1	3	B. blumeana	316	948	953.4	100	450	1503.4
	2	PET Plastic	2.7	5.4				
2	4	B. blumeana	316	1264	1266.7	100	450	1816.7
	1	PET Plastic	2.7	2.7				
3	6	B. blumeana	316	1896	1906.8	100	450	2456.8
	4	PET Plastic	2.7	10.8				
4	8	B. blumeana	318.7	2549.6	3181.6	100	450	3731.6

5. Conclusion and Recommendation

- Melting PET plastic without catalysts results in brittleness, making it waste. The researchers changed to weaving it.
- The proposed scaffold plank was formed using PET plastic and bamboo, with PVAc-D3 glue as a binding agent to maintain their properties.
- The study utilized seawater soaking to enhance bamboo's strength and serviceability, but did not protect it from termites or insects. Bamboo's long-term durability remains uncertain.
- The plastic and bamboo layers, none was completely broken and all samples deflected beyond the allowed limit, plastic-bamboo ratio is suitable

A. Recommendations

The following recommendations are offered for the possible improvement of this study. Bamboo layers should be higher than plastic layers. Melt plastic bottles with a catalyst to maintain mechanical properties. Protect bamboo from termites with solignum. Analyze the cost of the scaffold plank to determine its cost-effectiveness compared to commercial planks.

6. Acknowledgement

The researchers extend their deepest gratitude to the following individuals and institutions for their contributions and support to the completion of this study. The researchers express their gratitude to Engr. Jhun M. Jacinto for his invaluable support and guidance in the completion of this study, and to the School of Engineering of Aurora State College of Technology for providing the necessary academic environment.

Above all, the researchers want to give sincere gratitude to Almighty God for all of His favors, direction, and strength during this study journey. His grace has given them serenity, clarity, and determination through all of the difficulties and successes they have faced.

References

[1] Z. Huang, Z. Chen, D. Huang, and Y. H. Chui, "Cyclic loading behavior of an innovative semi-rigid connection for engineered bamboo-steel hybrid frames," *Journal of Building Engineering*, vol. 24, p. 100754, Jul. 2019, doi: 10.1016/J.JOBE.2019.100754.

[2] Y. Li, Q. Shan, M. Mao, and J. Zhang, "Study on the bond performance of bamboo-steel interface after cyclic loading," *Structures*, vol. 37, pp. 807–818, 2022, doi: https://doi.org/10.1016/j.istruc.2022.01.052.

[3] X. Zhang, K. Jiao, J. Zhang, and Z. Guo, "A review on low carbon emissions projects of steel industry in the World," *J Clean Prod*, vol. 306, p. 127259, 2021, doi: https://doi.org/10.1016/j.jclepro.2021.127259.

[4] Y.-Y. Wang *et al.*, "High-Performance Bamboo Steel Derived from Natural Bamboo," *ACS Appl Mater Interfaces*, vol. 13, no. 1, pp. 1431–1440, Jan. 2021, doi: 10.1021/acsami.0c18239.

[5] Y. Du, Y. Li, B. Yang, and J. Huang, "Design of steel-bamboo composite structure system," in *Applied Mechanics and Materials*, 2012. doi: 10.4028/www.scientific.net/AMM.204-208.908.

[6] M. F. V. Adier, M. E. P. Sevilla, D. N. R. Valerio, and J. M. C. Ongpeng, "Bamboo as Sustainable Building Materials: A Systematic Review of Properties, Treatment Methods, and Standards," Oct. 01, 2023, *Multidisciplinary Digital Publishing Institute (MDPI)*. doi: 10.3390/buildings13102449.

[7] M. Harshal Virkhare, M. Purnachandra Bramhankar, and M. V. Gajghate, "BAMBOO REINFORCEMENT IS CONSTRUCTIVE MATERIAL", [Online]. Available: www.irjmets.com

[8] P. Kumar, P. Gautam, S. Kaur, M. Chaudhary, A. Afreen, and T. Mehta, "Bamboo as reinforcement in structural concrete," in *Materials Today: Proceedings*, Elsevier Ltd, 2020, pp. 6793–6799. doi: 10.1016/j.matpr.2021.04.342.

[9] C. A. Bacosa Jr and M. E. Loretero, "BAMBOOS AS A GREEN SUSTAINABLE MATERIAL FOR CONSTRUCTION AND CIVIL ENGINEERING WORKS: A REVIEW," pp. 1671–5497, 2023, doi: 10.17605/OSF.IO/BJY9X.

[10] Ajla. Akšamija, John. Haymaker, and Abbas. Aminmansour, *Future of architectural research*. Perkins+Will, 2015.

[11] X. Luo, X. Wang, H. Ren, S. Zhang, and Y. Zhong, "Long-term mechanical properties of bamboo scrimber." [Online]. Available: https://ssrn.com/abstract=4043450

[12] Y. Yu, R. Zhu, B. Wu, Y. Hu, and W. Yu, "Fabrication, material properties, and application of bamboo scrimber," *Wood Sci Technol*, vol. 49, no. 1, pp. 83–98, Jan. 2015, doi: 10.1007/s00226-014-0683-7.

[13] G. Wu, Y. Zhong, Y. Gong, and H. Ren, "Mode II Fracture Toughness of Bamboo Scrimber with Compact Shear Specimen," *Bioresources*, vol. 13, pp. 477–486, Feb. 2018, doi: 10.15376/biores.13.1.477-486.

[14] R. Ismail, Y. C. Bon, N. A. Joolkeepri, and I. S. Ishak, "Strength Behavior of Bamboo-Reinforced Concrete Slabs," in *IOP Conference Series: Materials Science and Engineering*, Institute of Physics Publishing, Nov. 2018. doi: 10.1088/1757-899X/431/11/112003.

[15] A. Javadian, M. Wielopolski, I. F. C. Smith, and D. E. Hebel, "Bond-behavior study of newly developed bamboo-composite reinforcement in concrete," *Constr Build Mater*, vol. 122, pp. 110–117, Sep. 2016, doi: 10.1016/j.conbuildmat.2016.06.084.

[16] A. Tahmid, S. Reza Chowdhury, K. Abid Ahsan, and R. Kanti Sarkar, "A Review Of Bamboo As A Reinforcing Material In Concrete." [Online]. Available: https://www.researchgate.net/publication/368601725

[17] P. K. Singh, A. Jodhani, and A. P. Singh, "Bamboo as Construction Material and Bamboo Reinforcement," 2016. [Online]. Available: www.researchpublish.com

[18] B. Lv, Q. T. Xie, J. Xu, T. Y. Jiang, and Y. S. Li, "A new-type bamboo-steel composite structural member, box section bamboo-steel composite beams," in *Applied Mechanics and Materials*, 2011. doi: 10.4028/www.scientific.net/AMM.94-96.490.

[19] Q. Shan, J. Zhang, K. Tong, and Y. Li, "Study on Flexural Behaviour of Box Section Bamboo-Steel Composite Beams," *Advances in Civil Engineering*, vol. 2020, 2020, doi: 10.1155/2020/8878776.

[20] J. Zhang, Y. Du, Z. Yan, and Y. Li, "Study on bonding properties of bamboo-steel interface under static load," in *Applied Mechanics and Materials*, 2012. doi: 10.4028/www.scientific.net/AMM.166-169.176.

[21] M. Zhu, Y. Long, Q. Jiang, and J. Li, "Experimental study on bending bearing capacity of bamboo-reinforced concrete plate," 2015.

[22] X. Luo, X. Wang, H. Ren, S. Zhang, and Y. Zhong, "Long-term mechanical properties of bamboo scrimber," *Constr Build Mater*, vol. 338, p. 127659, 2022, doi: https://doi.org/10.1016/j.conbuildmat.2022.127659.

[23] J. Zhang, Y. Li, R. Liu, D. Xu, and X. Bian, "Examining bonding stress and slippage at steel-bamboo interface," *Compos Struct*, vol. 194, pp. 584–597, 2018, doi: https://doi.org/10.1016/j.compstruct.2018.04.037.

[24] Z. Li, C. Wang, and R. Wang, "Application of screw reinforcement in the slotted-in bamboo-steel-bamboo connections," *Structures*, vol. 33, pp. 4112–4123, 2021, doi: https://doi.org/10.1016/j.istruc.2021.07.024.

[25] J. Zhang, Z. Zhang, K. Tong, J. Wang, and Y. Li, "Bond performance of adhesively bonding interface of steel-bamboo composite structure," *J Renew Mater*, vol. 8, no. 6, 2020, doi: 10.32604/jrm.2020.09513.

[26] Y. Li, W. Shan, H. Shen, Z. W. Zhang, and J. Liu, "Bending resistance of I-section bamboo-steel composite beams utilizing adhesive bonding," *Thin-Walled Structures*, vol. 89, 2015, doi: 10.1016/j.tws.2014.12.007.

[27] Y. Li, H. Shen, W. Shan, and T. Han, "Flexural behavior of lightweight bamboosteel composite slabs," *Thin-Walled Structures*, vol. 53, 2012, doi: 10.1016/j.tws.2012.01.001.

[28] Q. B. Bui, A. C. Grillet, and H. D. Tran, "A bamboo treatment procedure: Effects on the durability and mechanical performance," *Sustainability (Switzerland)*, vol. 9, no. 9, Aug. 2017, doi: 10.3390/su9091444.

[29] S. Thangaraj and M. Murugan, "PERFORMANCE OF AN EPOXY-FILLER-MODIFIED BAMBOO-REINFORCED CONCRETE SLAB," *Materiali in Tehnologije*, vol. 57, no. 1, pp. 11–17, 2023, doi: 10.17222/mit.2022.637.

[30] L. L. Yu, F. Lu, D. C. Qin, H. Q. Ren, and B. H. Fei, "Combustibility Of Boron-Containing Fire Retardant Treated Bamboo Filaments," 2017.

[31] L. Yu, J. Cai, H. Li, F. Lu, D. Qin, and B. Fei, "Effects of Boric Acid and/or Borax Treatments on the Fire Resistance of Bamboo Filament."

[32] J. Xu, Q. Xie, and Y. Li, "Study on environmental protection energy type bamboo-steel composite wall," in *Advanced Materials Research*, 2012. doi: 10.4028/www.scientific.net/AMR.368-373.3396.

[33] W. Shangguan, Y. Gong, R. Zhao, and H. Ren, "Effects of heat treatment on the properties of bamboo scrimber," *Journal of Wood Science*, vol. 62, no. 5, pp. 383–391, Oct. 2016, doi: 10.1007/s10086-016-1574-3.

[34] Z.-Z. Li *et al.*, "Bamboo heat treatments and their effects on bamboo properties," *Constr Build Mater*, vol. 331, p. 127320, 2022, doi: https://doi.org/10.1016/j.conbuildmat.2022.127320.

[35] M. A. Dalhat, S. A. Osman, A. A. A. Alhuraish, F. K. Almarshad, S. A. Qarwan, and A. Y. Adesina, "Chicken Feather fiber modified hot mix asphalt concrete: Rutting performance, durability, mechanical and volumetric properties," *Constr Build Mater*, vol. 239, Apr. 2020, doi: 10.1016/j.conbuildmat.2019.117849.

[36] R. Defalla Abdel Hafez, M. Hadzima-Nyarko, S. M. Ahmed, and B. A. Tayeh, "Recycled Chicken Feather Sand as a Partial Replacement for Natural Sand for Producing Eco-Friendly Mortar," *Buildings*, vol. 13, no. 2, Feb. 2023, doi: 10.3390/buildings13020421.

[37] C. Pavithra, A. Arokiaprakash, and A. Maheshwari, "Behaviour of concrete adding chicken feather as fibre with partial replacement of cement with Cashewnut shell powder," in *Materials Today: Proceedings*, Elsevier Ltd, 2020, pp. 1173–1178. doi: 10.1016/j.matpr.2020.08.731.

[38] J. Huang, Y. Li, B. Yang, and Y. Du, "Study on the design of steel-bamboo composite member," in *Applied Mechanics and Materials*, 2012. doi: 10.4028/www.scientific.net/AMM.204-208.4047.

[39] Z. Li, T. Li, and Y. Xiao, "Connections used for cold-formed steel frame shear walls sheathed with engineered bamboo panels," *J Constr Steel Res*, vol. 164, 2020, doi: 10.1016/j.jcsr.2019.105787.

[40] H. Shen, Y. Li, W. Zhang, J. Xu, and B. Lü, "Experimental study on flexural behavior of cold-formed thin-wall steel-bamboo plywood composite beams," *Jianzhu Jiegou Xuebao/Journal of Building Structures*, vol. 30, no. SUPPL. 2, 2009.

[41] W. C. Gao and Y. Xiao, "Seismic behavior of cold-formed steel frame shear walls sheathed with ply-bamboo panels," *J Constr Steel Res*, vol. 132, 2017, doi: 10.1016/j.jcsr.2017.01.020.