IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 4, April 2026

DOI: 10.17148/IARJSET.2026.13433

EXPERIMENTAL INVESTIGATION OF ENERGY EFFICIENT MATERIAL FOR CONSTRUCTION.

Marba Doji[1], Modak Doji[2], Sahil Awasarmal[3], Rijwan Mujawar[4], Nilesh More[5], Dr. Pankaj Punase[6]

Civil Engineering Student, SSBT College of Engineering and Technology, Jalgaon, MH, India[1]

Civil Engineering Student, SSBT College of Engineering and Technology, Jalgaon, MH, India[2]

Civil Engineering Student, SSBT College of Engineering and Technology, Jalgaon, MH, India[3]

Civil Engineering Student, SSBT College of Engineering and Technology, Jalgaon, MH, India[4]

Civil Engineering Student, SSBT College of Engineering and Technology, Jalgaon, MH, India[5]

Head of Civil Engineering Department, SSBT College of Engineering and Technology, Jalgaon, MH, India[6]

Abstract: The construction industry plays a major role in economic development, but it also consumes a large amount of natural resources and energy. Conventional construction materials such as cement, steel, and concrete require significant energy for production and contribute to environmental pollution. In recent years, researchers have focused on developing sustainable and energy efficient construction materials to reduce environmental impact. Natural fibres have emerged as an effective alternative due to their renewable nature, low cost, and environmentally friendly characteristics. Among various natural fibres, banana fibre is considered highly promising because it is widely available as agricultural waste in many tropical countries.

This research paper presents an experimental investigation of banana fibre as an energy efficient material for construction. The main objective of this study is to evaluate the potential of banana fibre in cement-based construction materials and examine its effect on mechanical and thermal properties. Banana fibres were extracted from banana plant stems and processed before being mixed with cement mortar in different proportions. Laboratory tests such as compressive strength tests, tensile strength tests, and thermal insulation tests were conducted to evaluate the performance of fibre reinforced materials.

This research focuses on the experimental investigation of an energy-efficient cavity wall using banana fibres as an insulation material. Two wall models were constructed for the experiment: a conventional solid wall model and a cavity wall model filled with banana fibres.

Keywords: Banana Fiber, Energy Efficient Materials, Cavity Wall, Thermal Insulation, Sustainable Construction, Heat Transfer

I. INTRODUCTION

Energy consumption in buildings has become a major global concern due to the increasing demand for cooling and heating systems. Buildings account for a significant portion of global energy usage, particularly in urban areas where population density and infrastructure development are high. One of the major sources of heat transfer in buildings occurs through walls, roofs, and windows. Therefore, improving the thermal performance of building materials is essential for enhancing energy efficiency.

Conventional solid walls allow significant heat transfer from the external environment to the interior space, resulting in increased indoor temperatures. This often leads to higher energy consumption for air conditioning and cooling systems. To reduce heat transfer, cavity walls have been widely used in modern construction. A cavity wall consists of two parallel walls separated by a gap known as a cavity. This cavity can be filled with insulation materials to reduce heat transfer.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 4, April 2026

DOI: 10.17148/IARJSET.2026.13433

Various synthetic insulation materials such as fiberglass, polyurethane foam, and mineral wool are commonly used in cavity walls. However, these materials are often expensive and may have environmental impacts during manufacturing and disposal. As a result, researchers are exploring natural and biodegradable alternatives.

Natural fibres such as coconut fibre, jute fibre, bamboo fibre, and banana fibre have shown promising potential as insulation materials in construction. Among these, banana fibre is particularly attractive due to its availability, strength, and thermal insulation properties.

Banana fibre is obtained from the pseudo-stem of the banana plant after the fruit is harvested. In many agricultural regions, banana stems are discarded as waste. Utilizing banana fibres as insulation material not only improves building performance but also helps in waste management and environmental protection.

This research aims to experimentally investigate the thermal performance of a cavity wall filled with banana fibres and compare it with a conventional wall model. The study focuses on measuring the temperature difference inside both wall systems when exposed to external heat conditions. The findings of this research will contribute to the development of sustainable and energy-efficient building materials.

II. MATERIALS AND METHODS

The experimental study involved constructing two small wall models and comparing their thermal performance. One model represented a conventional solid wall, while the other represented a cavity wall filled with banana fibres as insulation.

2.1 Materials Used:

The following materials were used to construct the experimental wall models:

Cement

Ordinary Portland Cement (OPC) was used as the binding material for preparing the wall structures.

Fine Aggregate

River sand was used as fine aggregate in the cement mortar mixture.

Banana Fibres

Banana fibres were obtained from dried banana plant stems. These fibres were used as insulation material inside the cavity wall.

Agricultural Waste Materials

In addition to banana fibres, small amounts of other agricultural waste materials were included to enhance insulation properties.

Water

Clean potable water was used for mixing and curing.

2.2 Preparation of Banana Fibres:

The banana fibres used in the experiment were prepared using the following process:

1. Banana stems were collected from agricultural waste sources.
2. Fibers were extracted manually from the banana pseudo-stems.
3. The fibres were washed to remove dust and impurities.
4. The fibres were sun-dried for approximately 24–48 hours.
5. The dried fibres were cut into small pieces suitable for insulation use.

This preparation process ensured that the fibres were clean, dry, and ready for use as insulation material.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 4, April 2026

DOI: 10.17148/IARJSET.2026.13433

2.3 Construction of Wall Models:

Two wall models were constructed for the experiment.

Figure 1: Cavity Wall Model

Conventional Wall Model

The first model was constructed as a **solid wall structure** using cement mortar. This model represented a typical conventional wall used in building construction.

Banana Fibre Cavity Wall Model

The second model was constructed as a **cavity wall system** consisting of two parallel walls separated by a cavity space. The cavity space between the walls was filled with banana fibres and other agricultural waste materials to act as insulation.

Both wall models were constructed on a wooden base and allowed to cure properly for several days before conducting the experiment.

2.4 Experimental Setup:

The experimental setup involved placing both wall models under identical environmental conditions. External heat was applied to simulate high temperature conditions similar to those experienced during summer.

Temperature sensors were placed inside both wall models to measure internal temperature changes.

The experiment was conducted for a fixed duration, and teperature readings were recorded at regular time intervals.

Figure 2: Banana Stem

© IARJSET This work is licensed under a Creative Commons Attribution 4.0 International License

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 4, April 2026

DOI: 10.17148/IARJSET.2026.13433

2.5 Temperature Measurement Procedure:

The temperature measurement was carried out using the following procedure:

1. Both wall models were positioned in the same location.
2. External heat exposure was applied to both walls.
3. Temperature sensors were placed inside the cavity or internal chamber of each wall model.
4. Temperature readings were recorded every 10 minutes.
5. Observations were continued for approximately one hour.

The collected data was then analysed to compare the thermal performance of both wall systems.

Figure 3: Design Model

III. RESULTS

The temperature readings recorded during the experiment are presented in Table 1.

Table 1:
Temperature Comparison Between Conventional Wall and Banana Fibre Cavity Wall

Time (Minutes)	Conventional Wall Temperature (°C)	Banana Fibre Cavity Wall Temperature (°C)
0	30	30
10	33	31
20	36	32
30	39	33
40	41	34
50	44	35
60	46	36

Observations:

1. The temperature inside the conventional wall increased rapidly during the experiment.
2. The cavity wall with banana fibre insulation showed a slower increase in temperature.
3. The insulation material effectively reduced heat transfer through the wall.
4. The final temperature difference between the two wall systems was approximately **10°C**.

IV. DISCUSSION

1. The experimental results demonstrate that the cavity wall filled with banana fibre insulation performs better than the conventional wall in terms of thermal performance.
2. Heat transfer through walls mainly occurs through conduction. In a conventional solid wall, heat travels directly through the wall material, causing an increase in indoor temperature. This results in uncomfortable indoor conditions during summer and increases the need for cooling systems.
3. In contrast, the cavity wall system creates a gap between the outer and inner walls, which reduces direct heat transfer. When this cavity is filled with insulation materials such as banana fibres, the heat transfer rate decreases significantly.

DOI: 10.17148/IARJSET.2026.13433

4. Banana fibres contain natural air pockets and porous structures that help trap air and reduce thermal conductivity. This property makes them effective insulation materials.
5. Another advantage observed during the experiment is the potential for noise reduction. Natural fibre insulation materials can absorb sound waves, which may reduce noise transmission through walls.
6. The use of banana fibre insulation also offers environmental benefits. Since banana fibres are obtained from agricultural waste, their use in construction helps reduce waste disposal problems and promotes sustainable resource utilization.
7. Additionally, banana fibres are inexpensive and easily available in many regions. This makes them a suitable alternative to costly synthetic insulation materials.
8. However, natural fibres may absorb moisture over time, which could affect durability. Future studies can investigate fibre treatment methods to improve water resistance and long-term performance.
9. Overall, the results of this research indicate that banana fibre insulation can improve energy efficiency in buildings by reducing heat transfer and maintaining comfortable indoor temperatures.

V. CONCLUSION

This study investigated the use of banana fibre as a natural insulation material in cavity walls and compared its thermal performance with a conventional wall system.

The experimental results lead to the following conclusions:

1. Banana fibres can be effectively used as insulation material in cavity wall construction.
2. The cavity wall filled with banana fibre insulation maintained lower internal temperatures compared to the conventional wall.
3. The insulation material reduced heat transfer and improved indoor thermal comfort.
4. Banana fibre insulation may also contribute to noise reduction inside buildings.
5. The use of agricultural waste materials promotes sustainable and environmentally friendly construction practices.

The findings of this study suggest that banana fibre insulation has strong potential for use in energy-efficient buildings. The material is inexpensive, easily available, and environmentally sustainable.

Future research should focus on large-scale applications, durability testing, and the improvement of moisture resistance for natural fibre insulation materials.

REFERENCES

[1]. Li, Z., Wang, L., & Wang, X. (2006). Properties of hemp fibre reinforced concrete composites. *Composites Part A: Applied Science and Manufacturing*, 37(3), 497–505.

[2]. Pickering, K. L., Efendy, M. G. A., & Le, T. M. (2016). A review of recent developments in natural fibre composites and their mechanical performance. *Composites Part A: Applied Science and Manufacturing*, 83, 98–112.

[3]. Satyanarayana, K. G., Guimarães, J. L., & Wypych, F. (2007). Studies on lignocellulosic fibres of Brazil: Source, production, morphology, properties and applications. *Composites Part A*, 38(7), 1694–1709.

[4]. Yan, L., Chouw, N., & Jayaraman, K. (2014). Flax fibre and its composites – A review. *Composites Part B: Engineering*, 56, 296–317.

[5]. Aziz, S. H., & Ansell, M. P. (2004). The effect of alkalization and fibre alignment on the mechanical and thermal properties of hemp fibre reinforced composites. *Composites Science and Technology*, 64(9), 1219–1230.

[6]. Jawaid, M., & Abdul Khalil, H. P. S. (2011). Cellulosic/synthetic fibre reinforced polymer hybrid composites: A review. *Carbohydrate Polymers*, 86(1), 1–18.

[7]. Faruk, O., Bledzki, A. K., Fink, H. P., & Sain, M. (2012). Biocomposites reinforced with natural fibres: A review. *Progress in Polymer Science*, 37(11), 1552–1596.

[8]. Joseph, K., Thomas, S., & Pavithran, C. (1996). Effect of chemical treatment on the tensile properties of banana fibre reinforced composites. *Polymer*, 37(23), 5139–5149.

[9]. John, M. J., & Thomas, S. (2008). Biofibres and biocomposites. *Carbohydrate Polymers*, 71(3), 343–364.

[10]. Pothan, L. A., Oommen, Z., & Thomas, S. (2003). Dynamic mechanical analysis of banana fibre reinforced polyester composites. *Composites Science and Technology*, 63(2), 283–293.

[11]. Gupta, M., & Srivastava, R. K. (2016). Mechanical properties of hybrid fibres reinforced polymer composite: A review. *Polymers from Renewable Resources*, 7(2), 45–54.

[12]. Mohanty, A. K., Misra, M., & Drzal, L. T. (2005). Natural fibres, biopolymers, and biocomposites. *CRC Press*.

[13]. Rowell, R. M. (2012). Handbook of wood chemistry and wood composites. *CRC Press*.

[14]. Kabir, M. M., Wang, H., Lau, K. T., & Cardona, F. (2012). Chemical treatments on plant-based natural fibre reinforced polymer composites: An overview. *Composites Part B*, 43(7), 2883–2892.

DOI: 10.17148/IARJSET.2026.13433

[15]. Alavudeen, A., Rajini, N., Karthikeyan, S., Thiruchitrambalam, M., & Venkateshwaren, N. (2015). Mechanical properties of banana/kenaf fibre reinforced hybrid polyester composites. *Materials & Design*, 66, 246–257.

Web References

16. U.S. Department of Energy (DOE). (2022). *Energy Efficiency in Buildings – Materials and Technologies.* Available at: https://www.energy.gov/
→ Provides current global strategies for improving building energy performance.

17. Green Building Council of India (GBCI). (2023). *LEED Rating System for Energy Efficient Buildings.* Available at: https://www.gbci.org/
→ Explains LEED certification and how materials contribute to energy efficiency.

18. Central Public Works Department (CPWD). (2021). *Guidelines for Sustainable and Energy Efficient Buildings.* Available at: https://cpwd.gov.in/
→ Offers national recommendations on material selection and design strategies for energy conservation.

19. International Energy Agency (IEA). (2022). *Energy Efficiency Policies for the Building Sector.*

.