Cawangan Perak

# e - Proceedings

# IUGeT

## Proceeding for International Undergraduates Get Together 2024 (IUGeT 2024)

"Undergraduates' Digital Engagement Towards Global Ingenuity"

**2nd Edition**

Organiser :

**Department of Built Environment Studies and Technology, College of Built Environment, UiTM Perak Branch**

Co-organiser :

**INSPIRED 2024. Office of Research, Industrial Linkages, Community & Alumni (PJIMA), UiTM Perak Branch**

**Bauchemic (Malaysia) Sdn Bhd**

**Universitas Sebelas Maret**

**Universitas Tridinanti (UNANTI)**

Publication date :

**November 2024**

# e - Proceedings

IUGeT

**Proceeding for International Undergraduates Get Together 2024 (IUGeT 2024)**

"Undergraduates' Digital Engagement Towards Global Ingenuity"


Organiser :

**Department of Built Environment Studies and Technology, College of Built Environment, UiTM Perak Branch**

Co-organiser :

**INSPIRED 2024. Office of Research, Industrial Linkages, Community & Alumni (PJIMA), UiTM Perak Branch**

**Bauchemic (Malaysia) Sdn Bhd**

**Universitas Sebelas Maret**

**Universitas Tridinanti (UNANTI)**

Perpustakaan Negara Malaysia Cataloguing in Publication Data

No e- ISBN: 978-967-2776-42-0

Cover Design: Muhammad Anas Othman
Typesetting : Arial

e-ISBN: 978-967-2776-42-0

# iVUTI 2024 Committee

**Project Leader**
Ts Muhammad Naim Mahyuddin

**Assistant Project Leader 1**
Dr Ezzat Fahmi Ahmad

**Assistant Project Leader 2**
En Mohd Fadzli Mustaffa

**Secretariat 1**
Syahmimi Ayuni Ramli

**Secretariat 2**
Nur Afiqah Anuar

**Treasurer**
Dr Izrahayu Che Hashim

**Registration Team**
Dr Asmaa' Che Kassim
Dr Fatin Syazwina Abdul Shukor
Dr Suwaibatul Islamiah Abdullah Sani

**Certification Team**
Ts Nurul Huda Abdul Hadi
Ir Raja Nurulhaiza Raja Nhari
Dr Siti Jamiah Tun Jamil

**Graphic Team**
Mohammad Fitry Md Wadzir
Jannatun Naemah Ismam,
Nor Azizah Talkis
Wan Nur Hanani Wan Abdullah

**Promotion Team**
Nurulanis Ahmad@Mohamed
Najma Azman
Ts Sr Dr Asmat Ismail

**Evaluation Team**
Dr Suzanah Abdullah
Haslina Hashim
Azlizan Adila Mohamad
Noorsazwan Ahmad Pugi
Gs Dr Munirah Radin Mohd Mohktar
Mohd Najib Husain

**Publication Team**
Nur'Ain Ismail (Head)
Siti Nurhayati Hussin (Chief)
Dr Nuramira Anuar (Sub-chief)
Dr Paul Gnanaselvam A/L Pakirnathan
Noorlinda Alang
Norasyikin Abdul Malik
Halimatussaadiah Iksan
Nurdiyana Mohamad Yusof
Syaza Kamarudin
Dr Wan Nordiana Wan Ali
Dr Ida Nianti Mohd Zin
Dr Nurul Sahida Fauzi
Dr Noor Rizallinda Mohd Ishak
Dr Lizawati Abdullah
Iza Faradiba Mohd Patel
Nurfatima Wahida Nasir
Nazirul Mubin Mohd Noor

e-ISBN: 978-967-2776-42-0

# INCORPORATING BANANA PSEUDO STEM FIBRE (BPF) IN ENHANCING THE STRENGTH OF CONCRETE FOR PRECAST CONCRETE WALL

Nur Farah Diyana Muhamad[1], Mohd Najib Abd Rashid[2*], and Muhammad Naim Mahyuddin[3]

[1, 2, 3] Department of Built Environment Studies and Technology, College of Built Environment, Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus

*mohdn613@uitm.edu.my

**Abstract**
There is a need for innovation in precast concrete material due to the urgent need and demands in the construction activities and to achieve the Sustainable Development Goals (SDG). Several factors initiate the innovation of utilizing natural fibres in the concrete mixture, including the compromised structural performance in precast concrete which often leads to lower quality of concrete, increasing agricultural waste products which results in the increased amount of waste, and high carbon dioxide emissions due to the rising of cement production. Therefore, this study aims to utilize agricultural waste material to enhance the strength of concrete, which aligns with the SDG. The methods used for the proposed innovation involve empathizing, defining, ideating, developing the prototype, and testing and experimenting with the product. The key findings indicate that incorporating banana pseudo stem fibre (BPF) in concrete performs better than conventional concrete and other natural fibre concrete. Increasing agricultural wastes and high carbon emissions due to cement production hence leading to the incorporation of natural fibres in concrete which Is expected to overcome the issues as well as widen the level of marketability through enhanced mechanical properties, the market demand based on consumers' preferences, sustainability and environmental benefits and improved cost efficiency.

**Keywords:** *Concrete, banana pseudo stem fibre (BPF), sustainable materials*

## 1. INTRODUCTION

The idea of the proposed innovation focuses on the precast concrete wall for the Industrialised Building System (IBS). This innovation proposed a concrete mix design that incorporates agricultural waste in the concrete mix design to produce a product that will enhance the quality and improve the performance of the existing precast concrete wall. Hence, the research is conducted by proposing banana fibre as the new material. The research needs to be carried out in order to observe and identify the possibilities and benefits of using banana fibre for concrete production. Plus, an improvement in the quality of material used for the precast concrete will help in improving the functionality of the wall structure in terms of lesser defects of the structure, improved performance and promotes sustainability by using waste agricultural products (Biondini et al., 2011). On the other hand, utilizing agricultural waste such as banana fibre will benefit the environment by reducing the amount of banana plantation waste.

## 2. LITERATURE REVIEW

The increase of agricultural waste produced by the escalated production of agricultural products, driven by the expansion of agricultural industries, generates a substantial amount of waste. In Malaysia, as stated by Ann (2017) the agricultural waste generation was about 0.122 kilograms per capita per day in 2009, a figure projected to increase to 0.210 kilograms per capita per day by 2025 where globally, this results in 998 million tonnes of agricultural waste annually, with Malaysia alone contributing 1.2 million tonnes of this waste to landfills each year. On top of that, the high carbon dioxide ($CO_2$) emissions due to cement production pose environmental challenges because of high carbon dioxide ($CO_2$) emissions, despite its ability to provide durability and strength for construction purposes. For every pound of cement produced, it releases approximately 0.9 pounds of carbon dioxide into the atmosphere (Busch et al., 2022). Incorporating waste materials, specifically banana waste in this study, into concrete production can address this issue. This approach reduces agricultural waste and improves the properties of concrete.

Malaysia's status as one of the top countries globally for banana plantations contributes to its widely recognized agricultural prowess. It covers a 26,000-hectare area and produces an impressive 530,000 metric tons of bananas annually. Every year, over 4 tonnes of banana trash are produced, which pollutes the environment (Farhana & Amira, 2021). Pseudo stems are typically burned after drying or discarded as waste after harvesting, which results in substantial pollution. An estimated 220 tonnes of biomass, or waste containing Pseudo stems, are produced by a hectare of banana plantations. The Pseudo stems are known as part of the banana plant, which is portrayed as a trunk. Plus, the true stem, which is located underground and formed by the tightly overlapping leaf sheaths, produces the Pseudo stem. However, once the Pseudo stem bears the bananas, they cut down the pseudo stem from the base, resulting in the production of banana wastes (Badanayak et al., 2023). Previous studies show that the concrete's flexural strength can be enhanced, and cracking and spalling are significantly reduced when banana fibres are added (Afraz & Ali, 2021).

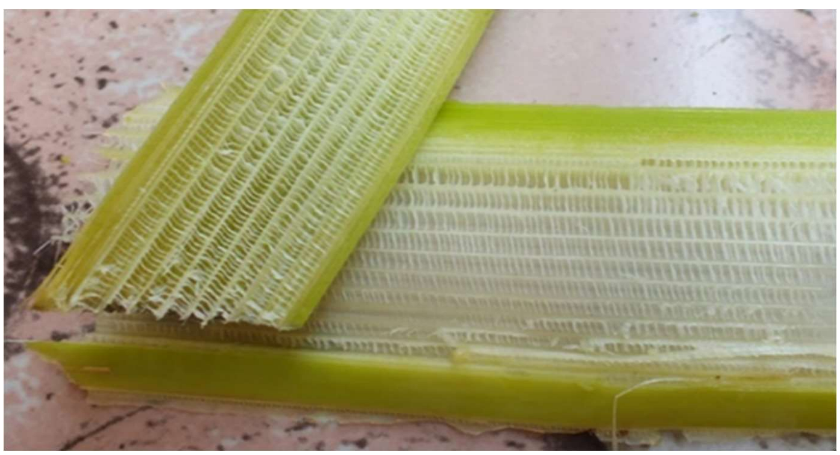

Figure 1. The banana pseudo stem

## 3. METHODOLOGY

Firstly, the materials used to develop the banana pseudo stem fibre (BPF) are based on the American Standard Testing Methods (ASTM) and British Standard (BS). The basic materials to produce a good quality of concrete include cement, coarse and fine aggregates as water where the water-cement ratio used for the mixture of lightweight concrete is kept at 0.5 of cement weight. The banana pseudo stem fibre *(Musa Balbisiana)* was collected at Taman Gemilang, Bandar Seri Iskandar in Perak. Secondly, the process of extracting the banana fibre is done through manual and chemical methods. Thirdly, the pseudo stem of the banana was measured at 3 to 5 cm in width and 20 to 30 cm in length. Then, the stem was cut according to the measurements before extracting the banana fibres from the stem. Also, an alkali treatment using sodium hydroxide (NaOH) caused the network structure of the hydrogen bonds to break and eliminate waste, oil, and lignin that was covering the fibre surface, increasing the roughness of the surface based on previous research.

e-ISBN: 978-967-2776-42-0

For this innovation project, the baking soda ($NaHCO_3$) is used to replace the sodium hydroxide to treat the BPF for approximately 1 hour with a 15% $NaHCO_3$ solution. Lastly, is to find the ideal ratio of strength to density while modifying the amount of BPF used to partially replace the cement to enhance the quality and strength of the concrete mixture. Hence, the mix ratio utilised for this innovation project is 1:1:2 for cement, sand, and aggregate involving three mix proportions namely the conventional, BPF1%, and BPF5% to produce 6 samples of cube moulds for both 7 and 28 days and the water-cement ratio is kept at 0.5 of the cement weight. The size of the cube moulds used for this innovation project is 100 mm x 100 mm x 100mm.

Table 1. Mix proportion of concrete

| **Material/ Type** | **Cement** | **Sand (Fine Aggregate)** | **Aggregate (Coarse Aggregate )** | **Water** | **Additional BPF (of cement weight)** |
|---|---|---|---|---|---|
| **Conventional Concrete (CC)** | 1.20 kg | 1.20 kg | 2.40 kg | 0.6 kg | - |
| **BPF 1%** | 1.19 kg | 1.20 kg | 2.40 kg | 0.6 kg | 0.012 kg |
| **BPF 5%** | 1.15 kg | 1.20 kg | 2.40 kg | 0.6 kg | 0.060 kg |

## 4. RESULT AND DISCUSSION

Based on the compressive strength test that has been conducted, it can be observed that at the 7 days of curing, the compressive strength of the sample for control with 0% additional banana pseudo stem fibre (BPF) showed 26.6 MPa and the compressive strength slightly increased to 27.4 MPa at 28 days. However, the value obtained for 1% additional of BPF with 0.5 water cement ratio shows a compressive strength of 30.4 MPa and increased to 36.8 MPa at 28 days. Next, an additional 5% of BPF presents the most notable strength and quality of concrete with 35.7 MPa and 42.1 MPa respectively. Hence, this proves that the additional 5% of BPF incorporated in the concrete mixture enhances the strength of concrete as well as produces better quality concrete for solid mix grade 25 as depicted in Figure 2.

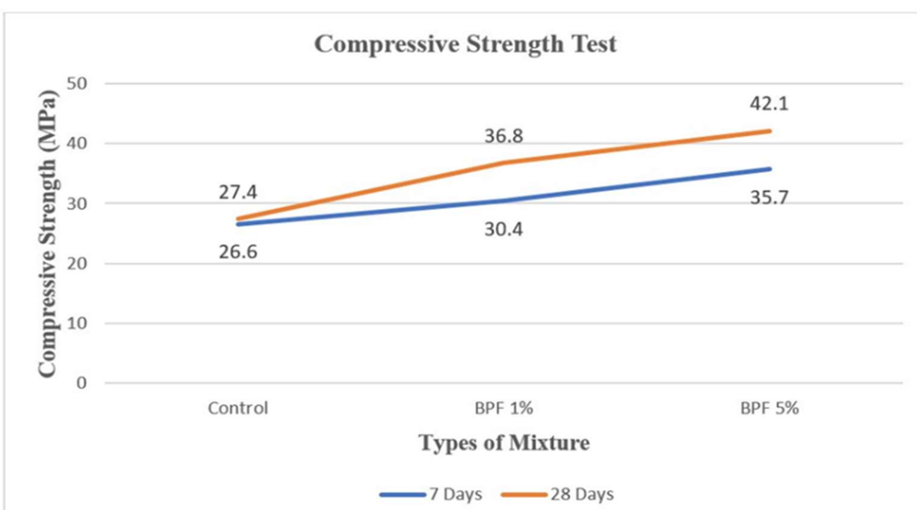


Figure 2. The compressive strength test result

The density test result after 28 days of curing where it is observed the conventional concrete sample after 28 days of curing shows the highest density compared to the BPF 1% and BPF 5% with 2241 kg/m3 mass in air and the mass in water decreased to 2217 kg/m3. The density of concrete samples continued to decrease with 2153 kg/m3 for mass in air and 2040 kg/m3 mass in water. The lowest density observed was in concrete samples with an additional 5% of BPF where the density observed was 1483 kg/m3 and the mass in water continued to decrease to 1289 kg/m3 as demonstrated in Figure 3. Overall, this proves that the density of concrete decreased as the percentage of fibre increased after 7 days of curing.

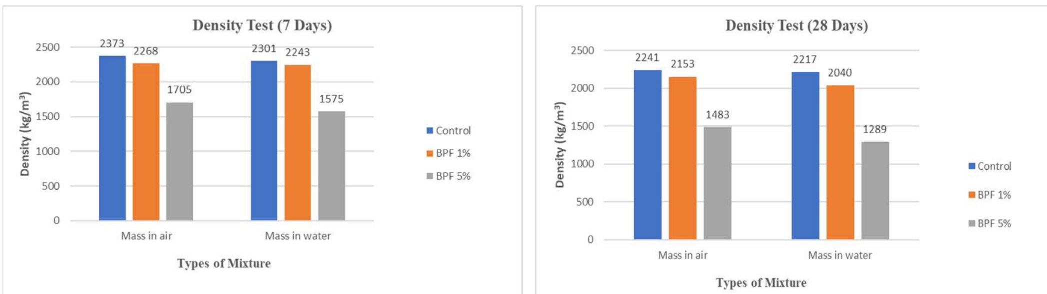


Figure 3. Density test result for 7 days and 28 days of curing

Next, based on Table 2, the UPV test conducted on concrete samples after 28 days of curing shows that conventional concrete has the lowest average velocity with 3921 m/s. Next, the second sample with 1% additional BPF where the average velocity increased slightly to 4193 m/s compared to the conventional. The third sample, which is a concrete sample with an additional 5% of BPF shows the highest average of velocity reading with 4381 m/s. Overall, the additional 5% of BPF after 28 days of curing shows the highest average velocity reading for the UPV test which indicates the highest strength and quality compared to the conventional concrete sample and sample with an additional 1% of BPF. It is also proven that the average reading of velocity for 7 days is higher compared to the average result of reading velocity for concrete samples after 7 days of curing as shown in Table 2.

Table 2. Ultrasonic Pulse Velocity (UPV) test result for 28 days of curing

| Types of mixture | Reading 1 (m/s) | Reading 2 (m/s) | Reading 3 (m/s) | Average (m/s) |
|---|---|---|---|---|
| Control | 3984 | 3755 | 3921 | 3921 |
| BPF 1% | 4084 | 4193 | 4102 | 4193 |
| BPF 5% | 4268 | 4170 | 4381 | 4381 |

## 5. CONCLUSION

Although concrete, which is the fundamental construction material, still requires improvement due to its limitations. Issues on the strength of concrete, especially involving the mechanical properties, are mostly highlighted. While there are many innovations developed, the environmental issues such as the high carbon emissions due to cement production. Hence, this innovation seeks to produce a new type of concrete that incorporates the banana pseudostem fiber (BPF) to overcome the issues as well as widen the level of marketability. By conducting the lab experiment, the compressive strength of concrete for 5% incorporation of BPF at 28 days achieved the highest reading with 42.1 MPa followed by concrete with 5% incorporation of BPF at 7 days with 35.7 MPa, higher than the conventional concrete. The density test showed that the BPF concrete samples were proven to be denser than the conventional concrete.

e-ISBN: 978-967-2776-42-0

The Ultrasonic Pulse Velocity (UPV) result where the concrete samples after 28 days of curing showed higher average reading compared to concrete samples after 7 days of curing which demonstrates that the longer curing process of the concrete will result in better homogeneity and strength of the concrete samples. This proves that the additional BPF into the concrete will result in better mechanical properties.

## 6. REFERENCES

Afraz & Ali. (2021). Effect of Banana Fiber on Flexural Properties of Fiber Reinforced Concrete for Sustainable Construction. *Eng. Proc.* 12(1), 63.

Ann T. et al. 2017. AgroCycle-developing a circular circular economy in agriculture Heating in AgroCycle developing an economy agriculture, *Energy Procedia,* vol. 123, pp. 76–80.

Badanayak et al. (2023). Banana pseudostem fiber: A critical review on fiber extraction, characterization, and surface modification. *Journal of Natural Fibers,* Volume 20, 2023 - Issue 1.

Biondini F. et al. (2011). Role of wall panel connection on the seismic performance of precast structures. *Bull Earthquake Eng.* 11:1061-1081.

Busch, P., Kendall, A., Murphy, C. W., & Miller, S. A. (2022). Literature review on policies to mitigate GHG emissions for cement and concrete. *Resources, Conservation and Recycling,* 182, 106278.

Farhana N. & Amira S. (2021). The Growing Biorefinery of Agricultural Wastes: A Short Review. *Journal of Sustainable Natural Resources* Vol. 2 No. 02 (2021) 46-51.

Cawangan Perak

e - Proceedings

IUGeT

Proceeding for International Undergraduates Get Together 2024 (IUGeT 2024)

"Undergraduates' Digital Engagement Towards Global Ingenuity"

e-Proceeding IUGeT 2024 2nd Edition

e ISBN 978-967-2776-42-0

Unit Penerbitan UiTM Perak

(online)