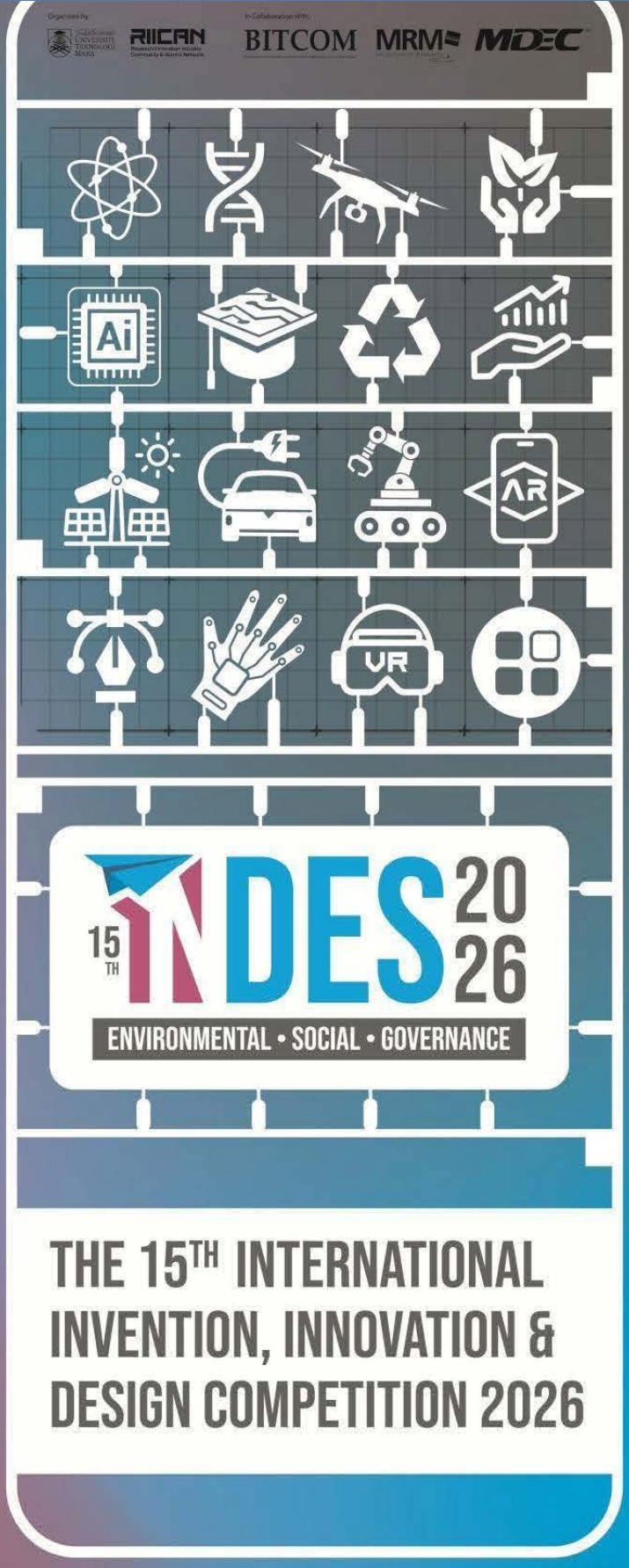

E-BOOK OF

EXTENDED ABSTRACT

E-BOOK OF EXTENDED ABSTRACT

THE 15th INTERNATIONAL
INVENTION, INNOVATION &
DESIGN COMPETITION 2026

Organized by:
Office of Research, Industry,
Community & Alumni Network
UiTM Perak Branch

© Unit Penerbitan UiTM Perak, 2026

All rights reserved. No part of this publication may be reproduced, copied, stored in any retrieval system or transmitted in any form or by any means; electronic, mechanical, photocopying, recording or otherwise; without permission on writing from the director of Unit Penerbitan UiTM Perak, Universiti Teknologi MARA Perak Branch.

Unit Penerbitan UiTM Perak,
Universiti Teknologi MARA,
Perak Branch, 32610
Seri Iskandar Perak, Malaysia.

Perpustakaan Negara Malaysia Cataloguing in Publication Data

No e- ISBN 978-967-2776-67-3

Cover Design: Asrul Nizuan Ariffin

Typesetting : Georgia

EDITORIAL BOARD

Editor-in-Chief

Muhd Syahir Abdul Rani

Managing Editors

Muhammad Wajihuddin Johari
Paul GnanaSelvam A/L Pakirnathan
Nazirul Mubin Mohd Noor
Nurdiyana Mohamad Yusof
Halimatussadiah Iksan

Copy Editors

Sheema Liza Idris
Nurul Munirah Azamri
Zarlina Mohd Zamari
NoorAileen Ibrahim
Farahidatul Akmar Awaludin
Siti Syairah binti Fakhruddin
Noor Fazzrienee JZ Nun Ramlan
Madaha binti Hanafi @ Mohd Ghani
Halimatun Saadiah Abd Mutalib
Hanitha A/P Satthiananthan
Syaza Kamarudin
Iza Faradiba Mohammad Patel
Nuramira Anuar
Noorlinda Alang
Noraziah Azizan
Faridatul Akma Wan Mohd Rashdi
Azurawati Zaidi
Ong Elly
Noran Nur Munira Khalili
Amirah Athirah Amir Yazid
Nurshahirah Azman
Daljeet Singh Sedhu A/L Janah Singh
Budiman Sabri Ahmad
Amirul Farhan Ahmad Tarmizi
Sarah Sakinah Assa'adah Johari

AEROSTRUX™ MODULAR WALL SYSTEM: HYBRID FIBRE LIGHTWEIGHT CONCRETE TECHNOLOGY FOR RAPID AND RESILIENT CONSTRUCTION

Izzat Anuar, Muhammad Assyahmizi Mohd Yunus, Ahmad Faisol Yusof, Mohd Zikri Mohd Zaki, Salahuddin Abdul Hakeem Abas, Farah Hanna Ahmad Fuad

Department of Built Environment Studies, Faculty of Built Environment, Universiti Teknologi MARA, Perak Branch, 32610 Seri Iskandar, Perak, Malaysia

izzat731@uitm.edu.my

ABSTRACT

The construction industry has continuously sought lightweight, sustainable, and structurally reliable materials to enhance efficiency and reduce environmental impact. This study introduced the AEROSTRUX™ Modular Wall System as an innovative wall solution developed from hybrid fibre-reinforced lightweight concrete (LWC). The research investigated the influence of polypropylene (PP) and nylon hybrid micro-synthetic fibres on the density and compressive strength of LWC under open-air curing conditions. Fibre configurations consisted of a control mix (0%), single-fibre mixes (0.5% PP and 0.5% nylon), and hybrid combinations at total volume fractions of 0.20%, 0.25%, and 0.30%, maintaining a 1:1 PP-to-nylon ratio. The results demonstrated that the incorporation of hybrid fibres improved matrix compaction, reduced air voids, and slightly increased density while significantly enhancing compressive strength compared to control and single-fibre mixtures. Optimal performance was achieved at a 0.25% hybrid fibre dosage, indicating effective stress transfer and crack-bridging synergy between PP and nylon fibres. These findings were subsequently translated into the development of a prefabricated modular wall panel system designed to support resilient construction strategies. The AEROSTRUX™ Modular Wall System was engineered to facilitate rapid installation, improved structural integrity, and enhanced thermal performance. Its lightweight yet strengthened composition made it particularly suitable for affordable housing developments, community facilities, temporary or post-disaster shelters, and small-scale commercial structures. By reducing structural load, accelerating construction time, and improving durability, the system contributed to adaptable and sustainable built environments capable of responding effectively to both long-term development needs and emergency situations.

Keywords: Lightweight Modular Wall, Hybrid Fibre, Sustainable Construction, Green Building Innovation

1. INTRODUCTION

Lightweight concrete (LWC) has attracted considerable attention in the construction industry due to its reduced self-weight, enhanced thermal insulation properties, and potential contribution to sustainable building practices (Alshannag et al., 2023; Lu, 2023). Despite these advantages, its broader structural application has been constrained by comparatively lower mechanical performance, particularly in terms of compressive strength and crack resistance (Guler, 2018; Shahpari et al., 2022). Recent advancements in fibre reinforcement technology have demonstrated that the incorporation of hybrid micro-synthetic fibres can significantly improve the mechanical behaviour of cementitious composites. Through enhanced crack-bridging mechanisms and more efficient stress distribution within the matrix, hybrid fibres have been shown to strengthen structural performance while maintaining the inherent benefits of LWC (Effendi Amran et al., 2019). Building upon prior experimental research on hybrid fibre-reinforced LWC, this innovation translated validated laboratory findings into a practical construction solution

known as the AEROSTRUX™ Modular Wall System. The system was developed to address industry demands for lightweight, durable, and rapidly

installable wall components, bridging the gap between material research and real-world construction applications.

2. METHODOLOGY

In the first phase, LWC mixes were prepared to evaluate the effect of hybrid fibre reinforcement on density and compressive strength. A control mix without fibres (0%) was established as a reference. This was followed by single-fibre mixes containing 0.5% PP and 0.5% nylon fibres to examine their individual contributions. Hybrid fibre mixes were then produced at total volume fractions of 0.20%, 0.25%, and 0.30%, maintaining a constant 1:1 ratio of PP to nylon fibres. All specimens were subjected to open-air curing to simulate practical site conditions. The primary testing parameters included density and compressive strength. These tests were conducted to assess material compactness, load-bearing capacity, and the overall mechanical improvement resulting from fibre incorporation. Table 1 presents the details of mixing proportion design.

Table 1 Details of Mixing Proportion

Specimen	Design Density (kg/m³)	Cement (kg/m³)	Sand (kg/m³)	Water (kg/m³)	Foam (kg/m³)	Volume Fraction of Fibre (%)	
						PP fibre	Nylon fibre
Control Mix	583.62	583.62	583.62	583.62	46.69	-	-
Single PP Fibre						0.50	-
Single Nylon Fibre						-	0.50
Hybrid Fibre 1						0.30	0.20
Hybrid Fibre 2						0.25	0.25
Hybrid Fibre 3						0.20	0.30

In the second phase, the optimal mix identified from the experimental results was translated into a modular wall prototype. The 0.25% hybrid fibre mix was selected due to its balanced improvement in density and compressive strength. This optimised composition was used to develop the AEROSTRUX™ Modular Wall System.

3. FINDINGS

The experimental results demonstrated that fibre incorporation significantly enhanced both the bulk density and compressive strength (Table 2) of LWC under open-air curing conditions. Compared to the control mix, fibre-reinforced specimens showed noticeable improvements in matrix compactness and mechanical performance. In terms of bulk density, hybrid fibre mixtures consistently achieved higher values than both the control and single-fibre mixes. Hybrid Fibres 3 recorded the highest density at all curing ages, indicating improved packing efficiency and reduced internal void formation. This enhancement was attributed to the synergistic interaction between PP and nylon fibres, which improved matrix cohesion and minimised microstructural porosity. Single-fibre mixes showed moderate improvement, while lower-performing hybrid configurations suggested that fibre dosage and dispersion play a critical role in compaction efficiency. A similar trend was observed in compressive strength development. The control mix exhibited the lowest strength throughout the curing period, whereas fibre-reinforced mixes demonstrated substantial improvement. Single PP Fibre and Hybrid Fibres 3 achieved

the highest compressive strength values, reaching approximately 10 MPa at 28 days. The enhanced performance was associated with improved crack-bridging mechanisms, better stress transfer, and strengthened fibre–matrix bonding. Overall, the correlation between increased density and higher compressive strength confirms that hybrid fibre reinforcement effectively improves matrix integrity and structural performance. These findings validate the suitability of the optimised hybrid mix for semi-structural applications and support its translation into the AEROSTRUX™ Modular Wall System.

Table 2 Bulk Density and Compressive Strength of Hybrid Fibre-Reinforced LWC

Specimen	Density (kg/m³)			Compressive Strength (MPa)		
	7	21	28	7	21	28
Control Mix	1210	1258	1259	2.10	2.85	2.00
Single PP Fibre	1545	1549	1543	8.90	10.15	10.60
Single Nylon Fibre	1468	1470	1472	5.10	5.45	6.65
Hybrid Fibre 1	1539	1544	1558	6.70	7.95	8.05
Hybrid Fibre 2	1349	1371	1369	3.05	3.35	3.70
Hybrid Fibre 3	1703	1726	1765	8.90	9.60	10.00

4. CONCLUSION

This study confirmed that hybrid micro-synthetic fibre reinforcement significantly improved the density and compressive strength of LWC under open-air curing conditions. The optimal hybrid fibre dosage demonstrated enhanced matrix compactness, better crack control, and improved load-bearing performance compared to control and single-fibre mixes. The positive relationship between increased density and compressive strength validates the effectiveness of the hybrid fibre system in strengthening LWC for semi-structural applications. These findings supported the development of the AEROSTRUX™ Modular Wall System as a lightweight, durable, and practical solution for modular and resilient construction.

REFERENCES

Ahmad, J., Zaid, O., Aslam, F., Martínez-García, R., Elharthi, Y. M., Hechmi EI Ouni, M., Tufail, F., & Sharaky, I. A. (2021). Mechanical properties and durability assessment of nylon fiber reinforced self-compacting concrete. *Journal of Engineered Fibers and Fabrics, 16*. https://doi.org/10.1177/15589250211062833

Alshannag, M., Alshmalani, M., Alsaif, A., & Higazey, M. (2023). Flexural performance of high-strength lightweight concrete beams made with hybrid fibers. *Case Studies in Construction Materials, 18*. https://doi.org/10.1016/j.cscm.2023.e01861

Blazy, J., & Blazy, R. (2021). Polypropylene fiber reinforced concrete and its application in creating architectural forms of public spaces. *Case Studies in Construction Materials, 14*. https://doi.org/10.1016/j.cscm.2021.e00549

Chaipanich, A., & Chindaprasirt, P. (2015). The properties and durability of autoclaved aerated concrete masonry blocks. In Eco-efficient Masonry Bricks and Blocks: Design, Properties and Durability (pp. 215–230). Elsevier Inc. https://doi.org/10.1016/B978-1-78242-305-8.00009-7

Lee, H. J., & Yang, K. H. (2023). Compressive and flexural toughness indices of lightweight aggregate concrete reinforced with micro-steel fibers. *Construction and Building Materials, 401*. https://doi.org/10.1016/j.conbuildmat.2023.132965

Lu, J. X. (2023). Recent advances in high strength lightweight concrete: From development strategies to practical applications. In Construction and Building Materials (Vol. 400). Elsevier Ltd. https://doi.org/10.1016/j.conbuildmat.2023.132905

Mydin, M. A. O. (2022). Influence of density, porosity and void Size on thermal conductivity of green lightweight foamed concrete. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, 92*(2), 25–35. https://doi.org/10.37934/arfmts.92.2.2535

Nematzadeh, M., Maghferat, A., & Zadeh Herozi, M. R. (2021). Mechanical properties and durability of compressed nylon aggregate concrete reinforced with Forta-Ferro fiber: Experiments and optimization. *Journal of Building Engineering, 41*. https://doi.org/10.1016/j.jobe.2021.102771

Peng, M., Huang, R., Peng, K., Wang, S., & Hai, L. (2025). Engineering properties of sustainable high strength lightweight concrete with recycled fibers. *Construction and Building Materials, 495*. https://doi.org/10.1016/j.conbuildmat.2025.143652

Seydmoradi, A., Tavana, M. H., & Habibi, M. R. (2024). Investigation on the response of steel fiber reinforced lightweight aggregate concrete slab under sequential impact loading. *Engineering Failure Analysis, 161*. https://doi.org/10.1016/j.engfailanal.2024.108221

E-BOOK OF EXTENDED ABSTRACT THE 15th INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2026

eISBN 978-967-2776-67-3

9 789672 776673

Date of Publication: 13 July 2026

UNIT PENERBITAN UITM PERAK

(online)