USM ICE'26
USM International Conference on Engineering 2026

UNIVERSITI SAINS MALAYSIA

APEX

AWAM INTERNATIONAL CONFERENCE IN CIVIL ENGINEERING 2026

AEROMECH 2026 | AICCE26 | ICRAIEM | RAMM | icenv 2026 | ISIS 2026

ADVANCES AI-DRIVEN AND SUSTAINABILITY-LED GLOBAL IMPACT



28-29 October 2026

Setia SPICE Convention Centre
Penang, **MALAYSIA**

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WELCOME TO USM

International Conference on Engineering 2026

Table Of **Content**

USM ICE 2026

USM ICE 2026 at a Glance 4

Message from the Campus Director 5

Message from the Vice-Chancellor 6

Officiating Ceremony 7

Acknowledgements 8

USM ICE'26 Organizers & Supporters 9

AICCE'26

AICCE'26 Organizers & Supporters 10

Message from the Conference Chair 11

Floor Layout 12

Keynote Speakers 13

Programme Schedule 14 – 16

- Day 1 · Wednesday, 28 October 2026 14
- Day 2 · Thursday, 29 October 2026 — Room FR8 15
- Day 2 · Thursday, 29 October 2026 — Room FR4 16

Abstracts (AICCE 26-0004 – 26-0130) 17 – 92

Closing Note 93



USM ICE 2026 at a Glance

The USM International Conference on Engineering 2026 (USM ICE 2026) marks a milestone event in conjunction with the 25th anniversary of the Tuanku Syed Sirajuddin Engineering Campus. With the theme **"Advances AI-Driven and Sustainability-Led Global Impact",** the conference highlights cutting-edge research and innovations that address global challenges through engineering excellence. Organized under the umbrella of USM ICE, each School within the Engineering Campus will host its own conference and symposium, creating a dynamic platform for knowledge exchange, collaboration, and showcasing impactful research. This inaugural event reflects Universiti Sains Malaysia's commitment to advancing technology, sustainability and international partnerships.

"ADVANCES AI-DRIVEN AND SUSTAINABILITY-LED GLOBAL IMPACT"

01	02	03	04	05	06
SCHOOL OF AEROSPACE ENGINEERING	SCHOOL OF CIVIL ENGINEERING	SCHOOL OF MECHANICAL ENGINEERING	SCHOOL OF MATERIALS & MINERAL RESOURCES ENGINEERING	SCHOOL OF CHEMICAL ENGINEERING	**CEDEC** COLLABORATIVE MICROELECTRONIC DESIGN EXCELLENCE CENTRE



Welcome Address

from the Campus Director, Tuanku Syed Sirajuddin Engineering Campus

Assalamualaikum Warahmatullahi Wabarakatuh,

It is my distinct honour and privilege on behalf of the USM Engineering Campus to welcome all delegates to the beautiful state of Penang. You are gathered in a really dynamic region, a nexus of rich cultural heritage and UNESCO-recognized history, and rapid industrial growth. Located conveniently close to important industrial corridors such as Batu Kawan, Penang is known across the world as the “Silicon Valley of the East” and offers an inspiring and highly relevant ecosystem for an engineering conference of this magnitude.

As we convene for this conference, we also take this opportunity to proudly celebrate the 25th anniversary of the USM Engineering Campus. This silver jubilee milestone represents 25 years of commitment to engineering excellence, impactful research, industry collaboration, and human capital development. It is a tribute to the collective efforts of our staff, students, alumni, industry partners and stakeholders who have helped develop the campus into one of the nation’s leading engineering education and research centers. This conference is part of our anniversary celebrations and is an ideal opportunity to reflect on what we have achieved and to chart new pathways for innovation and global collaboration in the years ahead.

Our Engineering Campus, home to a variety of specialized engineering schools and world-renowned Centers of Excellence, has always prided itself on fostering a vibrant and holistic research environment. We bridge the gap between rigorous academic research and the critical needs of industry.

We are always striving to challenge the limits of multi-disciplinary innovation, ensuring our collective research outcomes contribute directly to the Northern Corridor Economic Region (NCER), national development agendas and the acceleration of global technological progress.

The Fourth Industrial Revolution (IR 4.0) and the transition to a circular economy are driving a paradigm shift in the global engineering landscape. We are breaking down traditional academic silos and leveraging synergies across different branches of engineering combining machine learning with mechanical systems, marrying advanced nanomaterials with structural design, and integrating green technologies into everyday industrial processes to redefine how we approach the world’s most complex problems. Academia cannot work in silos anymore; we need to co-create solutions and build future-ready talent with industry leaders and policy makers.

I have no doubt that the state-of-the-art facilities, inter-faculty collaborations and the intellectually stimulating environment on our campus will provide the perfect setting for the discussions you will engage in over the coming days.

I hope you will use this unique multi-conference platform to network across disciplines, question the current quo, share new ideas, and explore future collaborations and research grants.

Also take the time to discover Penang's unique hospitality, rich culture and world-renowned cuisine. I wish you a very productive conference and an inspiring and memorable stay.

YBrs. Professor Ir. Dr. Mariatti Jaafar @ Mustapha
Campus Director, Tuanku Syed Sirajuddin Engineering Campus
Universiti Sains Malaysia



Message

Assalamualaikum Warahmatullahi Wabarakatuh,

I am delighted to extend a warm welcome to all the distinguished keynote speakers, delegates, industry partners and participants to this premier convergence of international engineering conferences hosted by Universiti Sains Malaysia (USM).

USM is the only university in the country that is an APEX (Accelerated Program for Excellence) university and USM is passionate to lead the sustainability and bring the changes to the world for the benefit of society. Our institutional philosophy stems in the belief that higher education must serve as a catalyst for sustainable development, addressing the urgent needs of today while protecting the future. In a world of rapid technological disruption and environmental issues, the scope of engineering goes far beyond infrastructure and machinery. It is the fundamental engine of all engines for climate resilience, for economic vitality, and for the betterment of humankind.

The global challenges we face cannot be solved in isolation. From climate change and resource scarcity to the complexity of digital transformation, artificial intelligence and rapid urbanization. What they need are integrated, multi-disciplinary solutions that draw on the combined expertise across all engineering sectors, from advanced manufacturing and electrical systems to resilient civil infrastructure, chemical processes, and aerospace technologies. In addition, our engineering efforts should be closely aligned with Environmental, Social, and Governance (ESG) principles and the spirit of the Malaysia MADANI vision, ensuring that technological progress is coupled with human-centric values and the United Nations' Sustainable Development Goals (SDGs).

The joint conference initiative is a strong indication of USM's grand vision of establishing strong global academic partnerships. We bring together the finest brains from diverse engineering disciplines and countries to create a vital, dynamic center for cross-sector working. These are the partnerships that bring together academia, government and industry that can translate the cutting edge theoretical research into real world impacts and commercialized innovations.

I would like to take this opportunity to express my appreciation to all organizing committees of the participating schools for their wonderful synergy in making this grand event possible. To our international guests who have come from afar and to our local participants I wish you a very engaging, productive, and fruitful conference. May the dialogues started here lead to long-term partnerships that will shape the future of engineering worldwide and inspire the next generation of technology leaders.

YBhg. Professor Dato' Seri Ir. Dr. Abdul Rahman Mohamed, FASc.
Vice-Chancellor
Universiti Sains Malaysia

USM INTERNATIONAL CONFERENCE ON ENGINEERING 2026

(USM ICE 2026)

OFFICIATING CEREMONY

Wednesday,28October2026 · 9:00AM

Setia SPICE Convention Centre, Penang

TIME	PROGRAMME
8:15 AM	**Registration**
8:50 AM	**Arrival of the Guest of Honour and VIPs**
9:00 AM	**Negaraku** *Welcoming Remarks and Opening Prayer*
9:10 AM	*Welcome Address:* **Professor Ir. Dr. Mariatti Jaafar@Mustapha** Campus Director Tuanku Syed Sirajuddin Engineering Campus Universiti Sains Malaysia
9:20 AM	*Officiating Speech and Official Launch:* **Professor Dato' Seri Ir. Dr. Abdul Rahman Mohamed, FASc.** Vice-Chancellor Universiti Sains Malaysia
9:30 AM	*Official Launch of:* **USM International Conference on Engineering 2026 (USM ICE 2026)**
9:40 AM	**Refreshments** **End of Ceremony**
10:00 AM	



ACKNOWLEDGEMENTS

The organizing committee is very grateful for the support and generosity of the following contributions towards the success of the USM ICE2026

- Director's Office, Tuanku Syed Sirajuddin Engineering Campus
- School of Aerospace Engineering
- School of Civil Engineering
- School of Mechinical Engineering
- School of Material dan Mineral Resource Engineering
- School of Chemical Engineering
- Collaborative Microelectronic Design Excellence Centre (CEDEC)
- Education Malaysia Global Services
- Ministry of Higher Education, Department of Higher Education,
- AI Enhancement Semiconductor Initiative

The organizing committee also wishes to extend its gratitude to individuals who had given support and assistance towards the success of USM ICE2026.

USM ICE'26

USM International Conference on Engineering 2026

Organized by



ICE USM Website

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AI Enhancement Semiconductor Initiative

AICCE26

AWAM INTERNATIONAL CONFERENCE IN CIVIL ENGINEERING

In conjunction with Malaysian Universities Transport Research Forum Conference (MUTRFC 2026)



Organized by

USM Universiti Sains Malaysia

APEX

TSTM Transportation Science Society of Malaysia

Co-organized by

Guangzhou University of Science and Technology

Chongqing University 1929

Universitas 17 Agustus 1945 Surabaya

REDAC River Engineering and Urban Drainage Research Centre

Sponsored by

IJM

PASTA PORT



AICCE'26 Chair's Foreword

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Asalamualaikum Warahmatullahi Wabarakatuh and welcome to the conference,

On behalf of the joint organizing and scientific committees I welcome you to this grand assembly of engineering conferences with a profound sense of pride, gratitude and enthusiasm.

The main objective of this mega event is to provide a dynamic, unifying, and high-level platform for researchers, academicians, industry practitioners and policy makers from various fields to come together. Over the past year, the response to our call for papers has been overwhelming with submissions from around the world. It reflects a profound global desire to share knowledge, benchmark our progress and collaborate across borders. In the face of the challenges of the unprecedented global change, the focus should be on the integrated, adaptive and forward-looking engineering solutions for the test of time.

During the next two days, we will discuss major breakthroughs in all participating engineering tracks. The well-designed program includes keynote addresses by world-class experts, highly specialized parallel technical sessions, booths in industry exhibition and extensive networking opportunities. We are also happy to inform you that the high-quality research presented here will be published in well reputed indexed proceedings and special issues of journals further establishing the academic legacy of this event. We want to show that doing interdisciplinary work is not only good, but essential for our future together. The innovations in these rooms will help lay the foundation for tomorrow's smart cities, advanced manufacturing plants and resilient infrastructures.

An event of this size and complexity is never the work of one person, nor is it the work of a single faculty. My deepest and most sincere gratitude goes to the joint secretariat and the organizing committee. Their tireless dedication, resilience and seamless teamwork over the past several months have brought this ambitious, unified vision to life successfully.

I wish to express my sincere gratitude to our distinguished international advisory board and our rigorous panel of peer-reviewers for maintaining the high scientific standards of this conference. We would like to thank our generous sponsors, government agencies and strategic industry partners, as your continued support across all conference tracks has been key to making this event a resounding success.

Finally, we wish to thank our distinguished keynote speakers, authors and all the participants, particularly the young post-graduate researchers and students who are the future of our profession, for sharing their diverse expertise and lively insights with us in this forum. I urge you strongly to step beyond your specific academic domains, to engage extensively with colleagues from other fields and to forge new collaborative ties.

Thank you for your participation and I wish you an inspiring, thought provoking and very successful conference.

Professor Ir. Dr. Fadzli Mohamed Nazri
AICCE'26 Conference Chair
School Of Civil Engineering
Universiti Sains Malaysia

FLOOR LAYOUT

MEETING & CONFERENCE SPACE

Lower Ground Floor

SETIA SPICE CONVENTION CENTRE



MEETING & CONFERENCE SPACE

Ground Mezzanine Floor

SETIA SPICE CONVENTION CENTRE



KEYNOTE SPEAKERS

AWAM International Conference in Civil Engineering 2026



Dato' Ir. Dr. Ahmad Farhan Mohd Sadullah

Former Vice Chancellor, Universiti Putra Malaysia (UPM), MALAYSIA



Prof. Dr. Huabei Liu

Huazhong University of Science and Technology (HUST), CHINA



Prof. Dr. Xiao Li

Chongqing University (CQU), CHINA



Dr. Ir. Ar. RA Retno Hastijanti

Universitas 17 Agustus 1945 (UNTAG), INDONESIA



PROGRAMME

Day 1 · Wednesday, 28 October 2026

TIME	PAPER ID	PRESENTER / ITEM	PAGE
OPENING PROGRAMME			
8.15 – 9.40 AM		ICE Launch	
9.40 – 10.15 AM		Morning Refreshment	
10.15 – 10.25 AM		Welcoming Speech	
10.25 – 11.25 AM		Keynote 1: Prof. Dr. Huabei Liu	
11.25 AM – 12.25 PM		Keynote 2: Prof. Dato' Ir. Dr. Ahmad Farhan Mohd Sadullah	
12.25 – 2.00 PM		Lunch	
ROOM FR8 — SESSION CHAIRPERSONS			
Chair		Ts. Dr. Fatehah Mohd Omar	
Chair		Assoc. Prof. Ts. Dr. Nur Sabahiah Binti Abdul Sukor	
Timer		Dr. Nuridah Sabtu	
SESSION 1 · 2.00 – 3.00 PM			
2.00 – 2.10	26-0050	Faridah Hanim Khairuddin	53
2.10 – 2.20	26-0016	Nur Fahriza Mohd Ali	28
2.20 – 2.30	26-0030	Lu Zhou	39
2.30 – 2.40	26-0049	Wang Xi	52
2.40 – 2.50	26-0053	Zhou Bingxue	55
2.50 – 3.00		Q&A Session	
SESSION 2 · 3.05 – 4.20 PM · Tea break 3.20 – 3.40 PM			
3.05 – 3.15	26-0058	Deng Haolin	59
3.15 – 3.25	26-0063	Aisha Iqbal	62
3.25 – 3.35	26-0004	Khalid Mehmood	18
3.35 – 3.45	26-0006	Cecilia Wong Thing	20
3.45 – 3.55	26-0060	Gs. Ts. Dr. Saznizam Sazmee Sinoh	60
3.55 – 4.05	26-0010	Ryo Nunogaki	22
4.10 – 4.20		Q&A Session	
SESSION 3 · 4.20 – 5.40 PM			
4.20 – 4.30	26-0011	Atsuki Furuta	23
4.30 – 4.40	26-0013	Andi Patriadi	25
4.40 – 4.50	26-0022	Dr. Andarita Rolalisasi	32
4.50 – 5.00	26-0028	Ho Jen Sim	37
5.00 – 5.10	26-0055	Zhang Ruixuan	56
5.10 – 5.20	26-0029	Zainiah Mohd Zin	38
5.20 – 5.30		Q&A Session	
5.30 – 5.40		**Best Presenter**	

Q&A session Refreshment / lunch break Best Presenter*

**One best presenter per session receives the Best Presenter award at the end of the day.*



PROGRAMME

Day 2 · Thursday, 29 October 2026 — Room FR8

TIME	PAPER ID	PRESENTER / ITEM	PAGE
PLENARY PROGRAMME · ROOM FR8			
8.30 – 9.30 AM		Keynote 1: Prof. Dr. Xiao Li	
9.30 – 10.15 AM		Morning Refreshment	
10.15 – 11.15 AM		Keynote 2: Dr. Ir. Ar. RA Retno Hastijanti	
11.15 – 11.45 AM		Special Presentation: Prof. Dr. Wengang Zhang	
ROOM FR8 — SESSION CHAIRPERSONS			
Chair		Dr. Mohd Amirul Bin Mohd Snin	
Chair		Dr. An Hong Ki	
Timer		Ts. Dr. Mohamad Al-Zaim Bin Omar	
SESSION 4 · 11.45 AM – 12.35 PM			
11.45 – 11.55	26-0032	Khaizal Jamaluddin	40
11.55 – 12.05	26-0062	Sharifah Allyana	61
12.05 – 12.15	26-0035	Ts. Mohd Azahar Bin Awang	42
12.15 – 12.25	26-0037	Hamed Aljamal	44
12.25 – 12.35		Q&A Session	
12.35 – 2.00 PM		Lunch	
SESSION 5 · 2.00 – 3.10 PM			
2.00 – 2.10	26-0098	Muhamad Nurfasya Alias	85
2.10 – 2.20	26-0056	Nusayba Megat Johari	57
2.20 – 2.30	26-0023	Muhammad Irfan Zafri Bin Mazlan	33
2.30 – 2.40	26-0036	Johnpaul V	43
2.40 – 2.50	26-0012	Kojiro Matsuo	24
2.50 – 3.00	26-0089	Natasha Binti Shiral	78
3.00 – 3.10		Q&A Session	
SESSION 6 · 3.15 – 4.25 PM · Tea break 3.20 – 3.40 PM			
3.15 – 3.25	26-0024	Mohammad Shahrul Ikhwan Bin Mahmad Pauzi	34
3.25 – 3.35	26-0025	Mohamad Zulikmal Firdaus Bin Mohd Yusri	35
3.35 – 3.45	26-0040	Mohd Syahrul Hisyam Bin Mohd Sani	45
3.45 – 3.55	26-0057	Norfaizah Binti Mohamad Khaidir	58
3.55 – 4.05	26-0097	Wenxin Yu	84
4.05 – 4.15	26-0020	Huang Shiqi	30
4.15 – 4.25		Q&A Session	
4.25 – 4.35		**Best Presenter**	

Q&A session Refreshment / lunch break Best Presenter*

**One best presenter per session receives the Best Presenter award at the end of the day.*



PROGRAMME

Day 2 · Thursday, 29 October 2026 — Room FR4

TIME	PAPER ID	PRESENTER / ITEM	PAGE
ROOM FR4 — SESSION CHAIRPERSONS			
Chair		Dr. Munder Abdullah Mohamed Bilema	
Chair		Dr. Cruze Alexander Daniel	
Chair		Ts. Dr. Nik Azimatolakma Binti Awang	
Timer		Mr. Muhammad Nor Hafizudin Mohd Aaini	
Timer		Mrs. Umi Syahida Hassan	
SESSION 7 · 11.40 AM – 12.30 PM			
11.40 – 11.50	26-0094	Ren Fubin	82
11.50 – 12.00	26-0048	Zeng Zimu	51
12.00 – 12.10	26-0090	Zou Zhiying	79
12.10 – 12.20	26-0093	Lu Weihao	81
12.20 – 12.30		Q&A Session	
12.30 – 2.00 PM		Lunch	
SESSION 8 · 2.00 – 3.10 PM			
2.00 – 2.10	26-0044	Kechen Li	47
2.10 – 2.20	26-0045	Jing Xu	48
2.20 – 2.30	26-0046	Yichen Liu	49
2.30 – 2.40	26-0047	Yang Lei	50
2.40 – 2.50	26-0026	Siti Fauziah Sopian	36
2.50 – 3.00	26-0070	Wu Xiangyan	67
3.00 – 3.10		Q&A Session	
SESSION 9 · 3.15 – 4.25 PM · Tea break 3.20 – 3.40 PM			
3.15 – 3.25	26-0069	Zhong Zichen	66
3.25 – 3.35	26-0052	Nurul Hidayah Binti Mat Raffee	54
3.35 – 3.45	26-0068	Wuzhen Yan	65
3.45 – 3.55	26-0033	Huiyi Yan	41
3.55 – 4.05	26-0076	Tharindu Sachintha Wimalasena	73
4.05 – 4.15	26-0079	Yuxuan Guo	76
4.15 – 4.25		Q&A Session	
SESSION 10 · 4.30 – 5.40 PM			
4.30 – 4.40	26-0071	Li Siqi	68
4.40 – 4.50	26-0072	Ke Li	69
4.50 – 5.00	26-0073	Vynotdni	70
5.00 – 5.10	26-0066	Yin Wenting	63
5.10 – 5.20	26-0091	Liu Han	80
5.20 – 5.30	26-0086	Mohd Fahmi Haikal Mohd Ghazali	77
5.30 – 5.40		Q&A Session	
5.40 – 5.50		**Best Presenter**	

Q&A session Refreshment / lunch break Best Presenter*

**One best presenter per session receives the Best Presenter award at the end of the day.*



AICCE26

AWAM INTERNATIONAL CONFERENCE IN CIVIL ENGINEERING

In conjunction with Malaysian Universities Transport Research Forum Conference (MUTRFC 2026)

ABSTRACTS

AICCE 26-0004

TRENDS OF SUSTAINABLE CONSTRUCTION MATERIALS AT BUILDING CONSTRUCTION PROJECTS ACROSS UNITED ARAB EMIRATES (UAE)

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Abstract

The construction industry is a major contributor to environmental degradation and is resource-intensive, which makes it the focal point to shift the paradigm from traditional to more sustainable construction materials adoption practices. This paper explores the current trends of sustainable construction materials across UAE construction projects. The research has adopted a qualitative research methodology, data collected from structured site observations of ongoing building construction projects, and data was analyzed using a hybrid inductive-deductive thematic analysis with the help of NVivo software. The results demonstrate two high-level themes, including barriers to sustainable material adoption and current trends in on-site sustainability practices. The most visible constraints were economic and supply chain, preceded by regulatory and stakeholder. Conversely, energy-efficiency practices, sustainable construction methods, and waste minimization were widespread, whereas material-level sustainability was selective and project-specific. The research concludes that the implementation of sustainability in building projects in the UAE is a highly emerging trend towards best sustainability practices. The contribution of this research study serves as empirical evidence of existing industry practices and offers a point of reference to policymakers, practitioners, and researchers who seek to advance the adoption of sustainable construction materials that are more comprehensive in the UAE.

Keywords: Construction Management, Project Management, Sustainability, Sustainable Materials, Sustainable Construction

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AICCE 26-0005

SMART CONSTRUCTION-ORIENTED STRENGTH PREDICTION OF RECYCLED LDPE CONCRETE USING MATLAB-ASSISTED REGRESSION MODELLING

Tuan Nurul Laiyyinah Tuan Lokman[1], Hooi Min Yee[1], Warid Wazien Ahmad Zailani[2], Chien Hwa Chong[3], Belinda Chong Chiew Meng[4], and Syahrul Fithry Senin[1], Arthit Petchsasithon[5]*

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[4]*Electrical Engineering Studies, Universiti Teknologi MARA, Kampus Permatang Pauh, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang, Malaysia.*
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Abstract

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The increasing accumulation of plastic waste and the depletion of natural construction materials have accelerated the demand for sustainable and smart concrete systems. While recycled low-density polyethylene (LDPE) shows great environmental potential as a partial concrete substitute, its incorporation can induce complex non-linear mechanical behavior that complicates strength predictions. This study has proposed a computational framework to predict the flexural strength behaviour of sustainable concrete reinforced with recycled LDPE and steel fibres. Predictive models were built using the experimental flexural strength data at 28 days of curing at LDPE replacement of 5%, 10%, and 15% with constant steel fibre dosage of 2%. All equations of linear, logarithmic, exponential, power-law, and quadratic regression were carried out and determined using coefficient of determination (R^2), percentage error (PE), chi-square goodness-of-fit analysis (χ^2), and Mean Bias Error (MBE). MATLAB-assisted prediction and laboratory validation were also performed for intermediate LDPE replacement levels of 7% and 12%. The results showed that the best regression model was obtained for the quadratic regression model ($R^2 = 1$, $\chi^2 = 0$, MBE = 0 MPa) since these predictive values were the closest to the experimental data. Steel fibres are said to promote crack-bridging and relieve stresses in the hydration matrix through SEM analysis and LDPE particles contain localized porous and weaker bonding regions, which accounts for the non-linear mechanical behaviour observed. In general, that the developed predictive computational framework minimizes the need for labor-intensive laboratory testing and provides the basis for data-informed sustainable concrete optimization, smart construction applications, and eco-friendly concrete engineering.

Keywords: Sustainable concrete; recycled LDPE; steel fibre reinforced concrete; regression analysis; MATLAB prediction; smart construction; computational modelling; bonding; optimization; concrete engineering.

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AICCE 26-0006

A COMPARATIVE STUDY ON THE STRUCTURAL PERFORMANCE OF DESIGN OF SINGLE-LANE, SINGLE-STOREY MODULAR STEEL BRIDGE FOR SHORT SPAN APPLICATION IN ACCORDANCE TO BRITISH STANDARDS AND EUROCODES

Cecilia Wong Thing[1], Fatimah De'nan[1]* and Kok Keong Choong[1]

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Abstract

A study of the structural performance of single-lane, single-storey modular steel bridge for short spans of 21 m and 30 m under British Standard (BS) and Eurocodes (EN) is presented in this paper. The study mainly focused on traffic loads as the leading variable action primarily contributing to the design forces and moments in the bridge with wind and thermal loads as secondary variable actions under normal traffic loads and combined abnormal and normal traffic loads. A sum of three load combinations under BS were determined and compared with one EN load combination under ultimate limit state and two EN load combinations under serviceability limit state after the consideration of suitable partial safety factors. The results were expressed in terms of maximum compression forces, maximum tension forces, maximum vertical shear forces, maximum sagging moment and maximum vertical deflection at the midspan of the bridge for the entire bridge superstructure. Maximum design forces and moments were extracted from ULS design while the maximum vertical deflection was extracted from the SLS design. Based on the analysis of results, BS produced larger maximum axial forces than EN while EN resulted in larger maximum vertical shear, sagging moment and vertical deflection under normal traffic load considerations. Under combined abnormal traffic and normal traffic loads, BS produced more conservative values for all parameters compared to that of EN. This study highlights the point that structural performance of a steel bridge design is very much dependent on traffic loadings to be considered in accordance to the corresponding design codes. As traffic loadings are span-dependent (in the case of HA UDL under BS Standard) and number of notional lane-dependent (in the case of LM1 loads under Eurocode), the differences in structural performance of designs of steel bridge should be evaluated on a case-by-case basis and not generalized for all cases.

Keywords: Modular steel bridge, British Standards, Eurocodes, STAAD.Pro, Traffic Loading

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AICCE 26-0009

ASSESSING THE IMPACT OF CONTRACT TERMINATION ON COST PERFORMANCE, SCHEDULE PERFORMANCE, AND OCCURRENCE RATE IN CONSTRUCTION PROJECTS

Michella Beatrix[1], Mochamad Firmansyah[2], Fanji Indrajaya Putra[3]

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Abstract

Contract termination is a major risk in construction projects, potentially affecting project cost, schedule, and quality. Despite the implementation of Indonesia's electronic tendering (e-tendering) system to enhance transparency, accountability, and efficiency in public procurement, contract termination remains a recurring issue in government construction projects. Previous studies have mainly focused on either the causes or the impacts of contract termination, while comprehensive analyses integrating causative factors, project impacts, and occurrence rates remain limited. This study aims to identify the dominant factors causing contract termination, analyze its effects on project cost and schedule, and determine the occurrence rate of contract termination in e-tendering-based government construction projects in Surabaya. A quantitative approach was employed using a questionnaire survey of 46 respondents selected through purposive sampling. Data were analyzed using descriptive statistics, validity and reliability tests, and simple linear regression with SPSS. The findings reveal that delays in work progress are the dominant cause of contract termination, with a mean score of 3.74. Regression analysis indicates that contract termination has a very strong effect on project cost and schedule ($R = 0.881$; $R^2 = 0.776$), implying that 77.6% of the variation in project cost and schedule performance is explained by contract termination. Furthermore, the occurrence rate of contract termination in e-tendering-based government construction projects in Surabaya during 2021–2026 was 2.06% (11 of 533 projects), while most respondents estimated additional costs ranging from 5% to 10% of the contract value. This study contributes by integrating the analysis of causative factors, project impacts, and occurrence rates into a single research framework. The findings provide practical insights for government agencies and construction service providers to strengthen project monitoring, improve risk mitigation strategies, and reduce the likelihood of contract termination in e-tendering-based construction projects.

Keywords: Termination of contracts, Construction projects, E-tendering, Project time and cost, Incidence rate.

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AICCE 26-0010

APPLICATION OF AN EXISTING EVALUATION METHOD TO THE ULTIMATE LATERAL RESISTANCE OF CFT PILES SUBJECTED TO SEISMIC LOADING

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Abstract

This study examines the applicability of an existing evaluation method for the ultimate lateral resistance of concrete-filled steel tubular (CFT) piles subjected to seismic loading. Although steel pipe piles are suitable for performance-based design because of their high ductility and stable hysteretic behavior, thin-walled steel pipe piles may lose their stability owing to local buckling. CFT piles are expected to suppress such instability by filling concrete into the steel tube. In this study, a centrifuge shaking-table test was conducted on a superstructure–CFT pile–soil system under a 40 g centrifugal field. The test results showed that the system reached its ultimate state when the inertial force became maximum, whereas plastic hinges did not form in the embedded portions of the piles. An existing evaluation method proposed for static loading conditions was then applied to the test results. The method overestimated the lateral resistance when the flexural strength of the CFT section was used. In contrast, good agreement was obtained when measured bending moments at the maximum inertial force were considered.

Keywords: CFT pile, Centrifuge model test, Ultimate state, Ultimate lateral resistance, Pile–soil interaction

AICCE 26-0011

STUDY ON LOAD SHARING OF GROUP PILES CONSIDERING NONLINEAR BEHAVIOR OF PILE MEMBERS

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Abstract

In recent years, performance-based design that allows damage to pile members has gradually been introduced in pile foundation design. However, available knowledge remains limited compared with that for superstructures. Steel pipe piles have high compatibility with performance-based design because of their high ductility and stable hysteretic characteristics. However, local buckling is a concern because they have thin-walled sections. In pile foundations, axial forces carried by each pile are not uniform. This is caused by pile arrangement, number of piles, and inertial force from superstructure. Therefore, each pile has a different stress state. When damage occurs in a pile, horizontal load acting on each pile is redistributed. This load sharing is considered to change with time depending on damage state of pile members. In this study, horizontal loading tests of steel pipe pile–soil systems were conducted using reduced-scale model specimens in a 50g centrifuge field. Damage progression of pile members was investigated until the system reached its ultimate state and subsequent deterioration. In addition, progression of pile damage was compared with change in horizontal load sharing among piles. This comparison clarified influence of nonlinear behavior of pile members on load-sharing characteristics of pile foundations.

Keywords: Centrifuge loading test, Local buckling, Nonlinear behavior

AICCE 26-0012

TRAFFIC SAFETY CONTRIBUTION OF SHŪDANTŌGEKŌ (GROUP SCHOOL COMMUTING) FOR ELEMENTARY SCHOOL STUDENTS IN JAPAN: A MACROSCOPIC ANALYSIS

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Abstract

In Japan, it is common for elementary school students to walk to and from school independently (i.e., without adult supervision) as early as the first grade. As an initiative to ensure student safety against traffic accidents and crimes, many schools have implemented group school commuting, known as "Shūdantōgekō", where older students safely lead younger ones. However, following several severe accidents in which vehicles plunged into lines of commuting students, debates have arisen regarding whether this practice is genuinely safe or if it increases the risk of multiple casualties. Despite these concerns, very few studies have quantitatively analyzed the traffic safety effects of Shūdantōgekō. Therefore, this study aims to empirically evaluate its impact on the frequency of elementary school student traffic accidents. Specifically, we conducted macro-level aggregate analyses and negative binomial regression modeling utilizing nationwide data across all 47 prefectures in Japan. The models analyzed the relationship between the percentage of schools implementing Shūdantōgekō and the number of school commuting-related accident casualties. The results demonstrated that a higher implementation rate of Shūdantōgekō significantly correlates with a lower frequency of traffic accidents, particularly during morning commuting hours. These findings suggest that while Shūdantōgekō carries a risk of multiple casualties in a single event, it provides a meaningful overall traffic safety benefit by substantially reducing the total accident frequency.

Keywords: Elementary school students, Traffic safety, Shūdantōgekō (Group school commuting)

AICCE 26-0013

EVALUATING DISCHARGE CONTINUITY IN A CONNECTED LOWLAND RIVER SYSTEM USING ADCP MEASUREMENTS: A CASE STUDY FROM PASURUAN, INDONESIA

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Abstract

Discharge measurement underpins water resources management in connected lowland river systems, where flow rarely behaves as a single channel from upstream to downstream. This study evaluates discharge continuity in an interconnected lowland river network in Pasuruan, East Java, Indonesia, in which irrigation canals, drainage channels, a retention pond, and a river confluence interact. Field discharge was measured at five cross sections using an ADCP SonTek RiverSurveyor M9, namely Upstream Teluk River (Location 1), Teluk River Bridge (Location 2), and three sections along the Masangan River (Locations 3 to 5). Discharge continuity was assessed by comparing the measured discharge before and after the confluence, where Location 4 lies downstream of the junction between Locations 2 and 3, and the residual discharge was quantified as the difference between the downstream discharge and the sum of the contributing branches. The measured discharge ranged from 0.640 to 3.960 m^3/s. Between Location 1 and Location 2 the discharge decreased by 0.102 m^3/s (13.7%), consistent with partial flow partitioning into a side channel. At the confluence, the discharge at Location 4 exceeded the sum of Locations 2 and 3 by 0.480 m^3/s (13.8%), a positive residual that may reflect lateral inflow, drainage or irrigation contributions, and possible storage release from the retention pond. Downstream, the discharge changed by only about 2.6% from Location 4 to Location 5, indicating a relatively stable reach. The results show that discharge variation, flow partitioning, residual discharge, and possible storage-induced lag must be read together, with due attention to measurement uncertainty.

Keywords: Discharge continuity, ADCP measurement, connected lowland river system, residual discharge, retention pond

AICCE 26-0014

EXPERT-DERIVED ANALYTIC HIERARCHY PROCESS FRAMEWORK FOR CATEGORY-LEVEL COST-RISK GOVERNANCE IN IRAQI HIGH-RISE PROJECTS

Abstract

Cost-risk governance in high-rise construction requires explicit trade-off judgement when managers must allocate contingency, tender-review effort, and executive attention across competing risk categories. This paper develops a standalone Analytic Hierarchy Process (AHP) framework for category-level cost-risk governance in Iraqi high-rise building projects. Fifteen senior experts completed the 15 pairwise comparisons required for six criteria: design, construction, external, financial, organisational, and country-specific risk. Individual matrices were screened using the AHP consistency ratio, and all matrices satisfied the conventional CR < 0.10 threshold. The geometric-mean aggregated group matrix produced priorities of 0.3127 for country-specific risk, 0.2485 for financial risk, 0.1295 for construction risk, 0.1283 for design risk, 0.1090 for organisational risk, and 0.0721 for external risk. The source-matrix audit gives lambda max = 6.0013, CI = 0.0003, and CR = 0.0002 using RI = 1.24. Leave-one-expert-out sensitivity confirms that the first two categories remain stable, while construction and design should be interpreted as a near tie. The resulting model supports category-weighted risk registers, contingency allocation, tender screening, and executive governance decisions in Iraqi high-rise projects.

Keywords: Analytic Hierarchy Process; cost-risk governance; high-rise construction; Iraq; expert judgement; pairwise comparison; multi-criteria decision making.

AICCE 26-0015

BOOTSTRAP-STABILISED RELATIVE IMPORTANCE INDEX RISK SCREENING FOR IRAQI HIGH-RISE BUILDING COST OVERRUN

Abstract

Cost overrun in Iraqi high-rise building projects is shaped by technical delivery risks and by volatile national, institutional, and financial conditions. This paper develops a Relative Importance Index (RII) risk-screening model from 254 valid practitioner responses covering 42 cost-risk factors across six categories. The study extends a basic RII ranking by adding reliability testing, factorability diagnostics, varimax-rotated principal component analysis (PCA), non-parametric group comparisons, bootstrap confidence intervals, and composite-formula sensitivity checks. The questionnaire showed strong internal consistency, with Cronbach alpha = 0.954 for frequency ratings, 0.949 for severity ratings, and 0.948 for the combined scale. The highest-ranked factors were corruption and bureaucratic delays, security risks, political instability and policy changes, inflation in construction materials, and exchange-rate volatility. Country-specific risks ranked first at category level (mean RII = 0.8255), followed by financial risks (mean RII = 0.7952). Bootstrap results showed stable top-tier ranks, while sensitivity checks confirmed that the leading risk factors remained dominant under additive, multiplicative, and weighted composite formulas. The paper contributes a reproducible RII-based screening workflow for pre-tender risk review and contingency planning in volatile high-rise construction markets.

Keywords: cost overrun; Relative Importance Index; high-rise construction; Iraq; bootstrap confidence intervals; risk screening; engineering management.

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BINARY TRAVEL MODE CHOICE CLASSIFICATION UNDER CLASS IMBALANCE USING KOLMOGOROV–ARNOLD NETWORKS: A STUDY OF TRAVELLERS IN KUANTAN CITY

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Abstract

Classification under class imbalance poses significant challenges in transportation analytics, particularly when minority classes represent critical or less frequently observed travel mode choices. This study proposes a Kolmogorov–Arnold Network (KAN) based classification framework for travel mode choice classification, designed to achieve a balanced trade-off between predictive accuracy, generalisation capability, and sensitivity to minority travel modes. The proposed approach is evaluated on an imbalanced two-class dataset representing distinct travel mode choices (SP_MODE=1 and SP_MODE=2), using overall accuracy, class-wise performance metrics, and confusion matrix analysis. The KAN model demonstrates strong representational capacity, achieving a training accuracy of 99.46%, while maintaining stable generalisation with validation and test accuracies of 82.28% and 81.25%, respectively. The close agreement between validation and test performance indicates that early stopping effectively mitigates overfitting, with the remaining generalisation gap primarily attributable to intrinsic data complexity, overlapping behavioural patterns, and heterogeneity in travel decision-making rather than model instability. Class-wise evaluation shows that the majority travel mode (SP_MODE=2) is identified reliably, achieving a precision of 0.84, recall of 0.91, and F1-score of 0.88. More importantly, the minority travel mode (SP_MODE=1) attains a precision of 0.71 and a recall of 0.55, representing a meaningful improvement over unweighted classifiers, which typically exhibit severely degraded recall for less frequently chosen travel modes under imbalanced conditions. The macro-averaged F1-score of 0.75 further confirms that model performance is not disproportionately influenced by the dominant travel mode. Confusion matrix analysis reveals a conservative error pattern, with misclassifications predominantly favouring the majority travel mode when uncertainty arises. This behaviour reflects genuine overlap in travellers' preferences and attributes across competing modes rather than arbitrary decision boundaries. Overall, the findings demonstrate that the proposed KAN framework effectively balances robustness and minority sensitivity, making it well suited for real-world travel mode choice modelling, transportation decision-support systems, and policy-driven planning applications. Future research may extend this framework to multi-class travel mode settings to enhance behavioural insight and policy relevance.

Keywords: Mode Choice; Class Imbalance; Machine Learning; Kolmogorov–Arnold Networks; Public Transport

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AICCE 26-0018

STUDY ON IMPROVING EXPANSIVE SOIL USING A SNAIL SHELL POWDER, LIME AND BACILLUS SUBTILIS BACTERIA COMBINATION IN SIDOARJO, INDONESIA

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Abstract

The Lapindo mud disaster has shifted the direction of residential development in Sidoarjo Regency, including towards Wonoayu District. However, the soil at the study site is classified as expansive clay with high plasticity, vulnerable to swelling and shrinkage, it requires improvement before serving as a construction subgrade. This study aims to evaluate the effects of combining snail shell powder, lime, and Bacillus subtilis on the physical and mechanical properties of expansive clay. An experimental approach was employed, involving tests for physical properties, compaction (Standard Proctor), and Unconfined Compressive Strength (UCS) across various admixture combinations. Curing periods from 0 until 14 days for Snail Shell Powder, and 3, 7, and 14 days for lime admixture. The results that the addition of Snail Shell Powder, lime, and Bacillus subtilis increa soil compaction characteristics and strength compared to the natural soil. The admixture of 15% snail shell powder and 6% Bacillus subtilis showing optimal conditions after 7 days of curing, whereas a mixture of 15% lime and 3% Bacillus subtilis achieved optimal conditions after 3 days of curing for Proctor tests and 7 days for UCS tests. Overall, the addition of stabilizing agents increased the Maximum Dry Density (MDD) and Unconfined Compressive Strength (UCS) values while reducing the Optimum Moisture Content (OMC). Although the improvements achieved with snail shell powder were lower than those with lime, are binding agent from industrial waste material fresh snail processing facilities, alternative calcium source for stabilizing expansive clay through biomineralization.

Keywords: Expansive Clay, Snail Shell Powder, Lime, Bacillus Subtilis, Soil Stabilization.

AICCE 26-0020

A BEHAVIORAL SAFETY FRAMEWORK FOR PEDESTRIAN-DIRECTED AGGRESSIVE DRIVING RECOGNITION USING EDR AND VIDEO DATA

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Abstract

Pedestrian-directed aggressive driving represents a particularly dangerous class of aberrant behavior in urban traffic environments. It poses not only an immediate threat to vulnerable road users but also broader concerns for public safety. While existing research on driving behavior has largely concentrated on general aggressive acts — such as speeding, abrupt lane changes, and tailgating — there remains a conspicuous gap in both the technical definition and methodological approach to identifying intentional, pedestrian-targeted aggressive maneuvers. This study proposes a behavioral safety analysis framework that fuses vehicle Event Data Recorder (EDR) outputs with video surveillance data to enable precise recognition and early warning of such behaviors. We anchor the framework in the Human-Vehicle-Environment (HVE) systems model from human factors engineering, allowing for a fine-grained spatiotemporal deconstruction of driving operation sequences. Three core aberrant patterns are formalized: targeted acceleration with trajectory locking, braking omission or symbolic braking, and logical inversion in operational sequencing—each supported by quantifiable indicators including longitudinal G-force, steering angular velocity, brake response time, and trajectory fitting error. The framework's applicability is examined across active safety systems, driver monitoring platforms, and in-depth traffic crash investigation. Validation through representative case studies demonstrates the framework's effectiveness. The primary contribution lies in extending EDR utility from conventional post-crash reconstruction to pre-crash behavioral identification and alerting, thereby offering actionable technical pathways for onboard active safety systems, usage-based insurance models, and enforcement intervention strategies — advancing the broader shift from reactive to proactive traffic safety management.

Keywords: intentional aggressive driving; Event Data Recorder (EDR); pedestrian safety; driving behavior pattern recognition; behavioral safety analysis

AICCE 26-0021

COMPARATIVE STUDY OF WATER AND WRAP CURING METHODS FOR FLY ASH-BASED GEOPOLYMER MORTAR UNDER AMBIENT CONDITIONS

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Abstract

Curing conditions can substantially affect the strength development of fly ash-based geopolymer mortar under ambient conditions. This study investigates the effect of water curing and plastic-wrap curing on the compressive strength of high-calcium fly ash-based geopolymer mortar activated with sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3). Two NaOH concentrations, 8 M and 12 M, were investigated using a Na_2SiO_3-to-NaOH mass ratio of 1:1, and an activator-to-binder ratio of 0.35. Cubic specimens measuring 5 × 5 × 5 cm were subjected to either water curing or wrap curing under ambient laboratory conditions and tested at 7 and 28 days. Water curing produced higher early-age compressive strength, whereas wrap curing resulted in higher strength at 28 days for both molarities. The highest compressive strength, 47.09 MPa, was obtained for the 12 M wrap-cured specimens at 28 days. These results indicate an age-dependent curing response, with water curing favoring early-age strength and wrap curing favoring later-age strength development.

Keywords: Geopolymer mortar, fly ash, water curing, wrap curing, ambient temperature.

AICCE 26-0022

WHOLE-LIFE CRITERIA FOR SUSTAINABLE HOUSING MATERIALS IN HOUSING DELIVERY: A STRUCTURED NARRATIVE REVIEW

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Abstract

Material selection has become a central issue in sustainable housing because the climate and resource implications of construction materials remain substantial even as operational energy performance improves. This paper presents a structured narrative review of sustainable housing materials for residential construction. The review integrates peer-reviewed review papers, comparative life-cycle assessment studies, housing-focused case studies, and institutional guidance to evaluate six material families: earthen materials, bamboo, engineered timber, bio-based composites and insulation systems, recycled and reused materials, and lower-carbon mineral systems. Rather than treating sustainable materials as product categories, the article assesses their suitability through whole-life criteria, including embodied carbon, durability, moisture risk, thermal performance, indoor environmental quality, affordability, local availability, regulatory readiness, and end-of-life recovery. The synthesis indicates that bio-based and natural materials often provide strong environmental potential, but their performance depends on detailing, treatment, code acceptance, and supply-chain capacity. Recycled and reused materials support circular construction when recovery, testing, and certification systems are reliable. Lower-carbon mineral systems remain important where structural robustness, conventional labour capacity, and large-scale delivery requirements dominate. The paper contributes a comparative decision framework that links material performance to housing delivery conditions rather than isolated environmental indicators. The findings support context-specific material selection based on whole-life performance, occupant health, affordability, and implementation capacity, especially in humid, tropical, and lower-income contexts where durability and local production systems strongly influence outcomes.

Keywords: sustainable housing materials; whole-life carbon; life-cycle assessment; indoor environmental quality; circular construction; affordable housing; tropical housing

AICCE 26-0023

AI PREDICTIVE ANALYTICS ADOPTION FOR DELAY RISK MANAGEMENT IN MALAYSIAN PUBLIC INFRASTRUCTURE: A SYSTEMATIC REVIEW

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Abstract

Construction delays remain a persistent risk in Malaysian public infrastructure projects because multi-agency approvals, funding constraints, land and site uncertainty, fragmented stakeholder coordination, and weak information flows shape public works. Traditional tools such as the Critical Path Method, Earned Value Management and Monte Carlo Simulation remain useful for planning and monitoring, but they are frequently applied after variance has already appeared. Artificial intelligence (AI)-powered predictive analytics offers a more proactive approach by using historical project data, real-time progress records, risk registers, site information and digital construction data to estimate delay probability and support earlier mitigation. Nevertheless, adoption in Malaysian public-sector construction remains constrained by data readiness, AI awareness, organisational capability, digital infrastructure, cost, interoperability, cybersecurity and policy governance. This systematic literature review synthesises research on construction delay, AI predictive analytics, digital construction, and technology adoption, using the PRISMA 2020 reporting principles and the Technology-Organisation-Environment framework as the main analytical lens. The synthesis shows that successful adoption depends not only on algorithmic performance but also on reliable project data, skilled users, management support, interoperable digital platforms and public-sector governance. The paper contributes an integrated conceptual framework and implementation roadmap for AI-powered delay-risk management in Malaysian public infrastructure projects. The findings provide a structured foundation for empirical validation involving public clients, consultants, contractors and infrastructure project managers.

Keywords: Artificial intelligence, predictive analytics, construction delay, public infrastructure, systematic review

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FROM BIM ADOPTION TO DIGITAL READINESS: A SYSTEMATIC REVIEW OF MULTIDISCIPLINARY CONSTRUCTION MANAGEMENT PERFORMANCE

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Abstract

Building Information Modelling (BIM) has become a central digital mechanism for improving coordination, information exchange and project performance in architecture, engineering and construction projects. Nevertheless, BIM adoption alone does not guarantee multidisciplinary construction management improvement because its value depends on organisational digital readiness, competent personnel, interoperable platforms, data governance, leadership support and discipline-level collaboration. This paper presents a systematic literature review of BIM adoption and digital readiness in relation to multidisciplinary construction management performance. A PRISMA-informed review procedure was applied to organise search terms, define inclusion and exclusion criteria, screen relevant studies, appraise methodological quality and synthesise evidence from peer-reviewed construction management, BIM, digital transformation and project performance literature. The synthesis is structured around six review questions covering publication trends, BIM adoption factors, digital readiness dimensions, implementation barriers, performance outcomes and framework development. The review indicates that BIM contributes to improved clash detection, constructability analysis, schedule coordination, cost control, quality assurance, safety planning and lifecycle information management when supported by mature digital infrastructure, standardised information requirements, common data environment practices and collaborative project governance. The review also confirms persistent barriers, particularly skill gaps, interoperability limitations, implementation cost, weak standardisation, cultural resistance and unclear contractual responsibilities. The main contribution of this paper is an integrated SLR framework linking BIM adoption, digital readiness, implementation barriers and multidisciplinary construction management performance. The framework provides a structured basis for future empirical testing and supports policy, organisational and project-level strategies for digital construction transformation.

Keywords: BIM, Digital readiness, Systematic review, Construction management, Project performance

AICCE 26-0025

DIGITAL INTEGRATION FOR PROACTIVE RISK MANAGEMENT IN CONSTRUCTION: A SYSTEMATIC LITERATURE REVIEW OF BIM, AI, AND IOT

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Abstract

The construction industry is under pressure to manage project risk more proactively while responding to digitalisation, sustainability, and Construction 4.0 agendas. Building Information Modelling (BIM), Artificial Intelligence (AI), and the Internet of Things (IoT) are frequently discussed as complementary technologies for early risk identification, predictive analytics, real-time monitoring, and evidence-based decision-making. However, the literature remains fragmented because many studies examine BIM, AI, or IoT separately, while fewer studies synthesise how their integration supports proactive construction risk management, particularly in developing construction markets such as Malaysia. This paper examines the role of BIM, AI, and IoT integration in proactive risk management. The review protocol is structured according to PRISMA 2020 principles and management-review guidance, with proposed searches in Scopus and Web of Science using controlled keyword strings covering BIM, AI, IoT, digital twins, Construction 4.0, and risk management. The paper develops research questions, eligibility criteria, data extraction fields, quality appraisal criteria, and a thematic synthesis framework. The synthesis indicates that BIM functions as the information-integration and visualisation platform, AI contributes predictive intelligence and decision support, and IoT supplies real-time sensing and site-condition data. Their combined value lies in moving construction risk management from reactive reporting toward predictive and preventive control. The paper presents an integrated BIM-AI-IoT risk-management framework, identifies implementation barriers across interoperability, cost, cybersecurity, skills, and governance, and outlines a future research agenda for empirical validation in Malaysian construction projects.

Keywords: BIM, Artificial Intelligence, Internet of Things, Risk Management, Construction 4.0

AICCE 26-0026

ACCURACY–EFFICIENCY TRADE-OFF IN EXPLAINABLE TRANSFER LEARNING FOR MULTI-CLASS CRACK CHARACTERIZATION OF HERITAGE MASONRY BUILDINGS

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Abstract

Recently, deep learning (DL)-based crack assessment has gained increasing attention in the inspection of heritage masonry buildings (HMBs). However, most existing studies remain focused on binary crack detection, with limited emphasis on multi-class crack characterization and model interpretability. This study proposes an explainable transfer learning (TL) approach for classifying heritage masonry surface images into five categories: vertical crack, horizontal crack, step crack, diagonal crack and intact surface. Two pre-trained models, EfficientNetB0 and MobileNetV2, were evaluated using a fixed stratified 70/15/15 split. EfficientNetB0 was adopted as the main accuracy-oriented model, while MobileNetV2 was used as a lightweight comparative model. The results show that EfficientNetB0 achieved superior performance, with 96.68% accuracy, 96.69% macro-F1 score and 96.70% balanced accuracy, compared with 85.31%, 85.08% and 85.28% for MobileNetV2, respectively. Grad-CAM visualization further demonstrated that the model generally focused on relevant crack regions. The findings indicate the potential of explainable TL for reliable multi-class crack characterization in HMBs.

Keywords: Heritage masonry buildings, crack characterization, transfer learning, EfficientNetB0, MobileneNetV2, Grad-CAM, deep learning

AICCE 26-0028

A LONGITUDINAL SPATIOTEMPORAL ANALYSIS OF SHARED E-SCOOTER UTILIZATION AND IDLE DYNAMICS IN KUALA LUMPUR

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Abstract

Shared electric scooters (e-scooters) have emerged as an important component of urban micromobility systems, yet prolonged vehicle inactivity can reduce operational efficiency and increase resource wastage. Despite growing interest in shared micromobility, limited studies have examined the spatiotemporal dynamics of e-scooter reuse, particularly in Malaysia. This study investigates shared e-scooter utilization and idle dynamics in Kuala Lumpur using a full-year operational dataset comprising 1,077,173 trips recorded in 2024. Kaplan–Meier survival analysis was employed to characterize vehicle reuse patterns, while spatial analysis was used to identify operational efficiency zones. The results indicate that shared e-scooters are predominantly used for short-distance travel, with approximately 80% of idle vehicles reused within 24 hours and more than 90% reused within 72 hours. Pronounced hourly variations in reuse dynamics were observed, while spatial analysis identified four operational zone types exhibiting considerable heterogeneity in utilization performance. The findings demonstrate that operational efficiency is determined not solely by demand intensity, but by how effectively fleet supply is aligned with local demand conditions. The study provides practical insights for demand-responsive deployment and targeted fleet rebalancing to support sustainable micromobility operations.

Keywords: Shared e-scooters; Micromobility; Idle duration; Survival analysis; Fleet utilization; Spatial analysis; Kuala Lumpur.

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MECHANICAL PERFORMANCE AND FIELD EVALUATION OF NATURAL RUBBERS AND SYNTHETIC POLYMER MODIFIED ASPHALT

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Abstract

At elevated temperatures, asphalt pavement exhibits an increased susceptibility to permanent deformation. This distress can be effectively mitigated via asphalt binder modification using polymer modifiers. In tropical climates, where pavement temperatures are consistently high, optimising these modifications is essential for ensuring long-term pavement durability. Therefore, the present study aims to determine the rutting resistance of modified asphalt mixtures through mechanical and field evaluations, including structural performance and in-situ rutting measurements collected 12 months post-construction. The mechanical performance of the mixtures was measured through volumetric analysis, Marshall stability, resilient modulus, and dynamic creep tests. Structural performance was assessed using a Falling Weight Deflectometer (FWD), while field rutting was measured using a straightedge and Multi Laser Profiler (MLP). Cup lump rubber (CLR) and natural rubber latex (LR) served as the natural rubber components, whereas polyolefin-aramid fibres (PAF) were adopted as the synthetic polymer. A 60/70 asphalt binder was blended with 5% CLR and 3% LR by weight of the binder. Additionally, 0.05% PAF by weight of the asphalt mixture was incorporated into the mixture using the dry mixing process. The resulting modified asphalt mixture outperformed the control 60/70 binder in Marshall stability. Furthermore, field rutting evaluations confirmed that the PAF-modified mixture provided excellent resistance to high-temperature rutting in tropical regions. In contrast, the 60/70 asphalt mixture exhibited the highest rut depth despite its high stability.

Keywords: Cup lump rubber-modified asphalt, natural rubber latex-modified asphalt, polyolefin and aramid-fibre modified asphalt, mechanical performance, field assessment.

AICCE 26-0030

YOLO-DDA: A YOLO-BASED DUAL-DOMAIN ATTENTION NETWORK FOR LOW-LIGHT PEDESTRIAN DETECTION

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Abstract

Low-light pedestrian detection aims to accurately localize and recognize pedestrian targets under low-illumination conditions. Existing detection methods are affected by background noise and struggle to effectively identify small objects, thereby limiting their detection accuracy. To address these challenges, we propose YOLO-DDA, which consists of two key components: the Dual-Domain Attention Block (DDAB) and the FFTLiteBlock. Specifically, the DDAB suppresses background noise by jointly modeling spatial and channel-domain information. Furthermore, the FFTLiteBlock transforms features into the frequency domain to enhance high-frequency structural information, thereby improving the model's ability to detect weak-texture and small-scale pedestrians. Experimental results demonstrate that YOLO-DDA achieves superior performance compared to state-of-the-art (SOTA) methods, while effectively balancing accuracy, the number of parameters, and FLOPs.

Keywords: Low-light pedestrian detection, Multimodal fusion, Attention mechanism, Frequency-domain modeling, YOLO Object detevtion

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INTEGRATED GEOENGINEERING CHARACTERIZATION OF QUATERNARY DEPOSITS USING MASW AND CPT METHODS: A CASE STUDY OF BANDA ACEH, INDONESIA

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Abstract

Quaternary deposits are commonly characterized by significant spatial variability due to their depositional environments, making reliable subsurface characterization essential for geotechnical investigations. This study evaluates the geoengineering characteristics of Quaternary soils by integrating the Multichannel Analysis of Surface Waves (MASW) and Cone Penetration Test (CPT) methods. CPT is a well-established in-situ geotechnical testing method that evaluates soil resistance under large-strain conditions, whereas MASW is a non-invasive geophysical technique that measures shear wave velocity (Vs) under small-strain conditions. Despite their different strain levels, both methods provide valuable information on subsurface stiffness and stratigraphic variation. A 100-m-long two-dimensional MASW survey and two CPT soundings were conducted at closely spaced locations to facilitate comparison between the datasets. The results indicate a good qualitative agreement between the shear wave velocity (Vs) profile obtained from MASW and the cone tip resistance (qc) measured by CPT, with both methods consistently identifying variations in subsurface soil layers. Although the comparison is qualitative, the findings demonstrate that MASW can effectively complement conventional CPT investigations for geoengineering site characterization. The integration of MASW and CPT provides a practical approach for improving the interpretation of subsurface conditions in Quaternary deposits.

Keywords: material geology, geoengineering properties, geotechnical investigation, MASW, CPT.

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AICCE 26-0033

ASSESSMENT OF INDOOR AIR QUALITY AND THERMAL COMFORT IN A TROPICAL UNIVERSITY HEALTHCARE FACILITY

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Abstract

Indoor air quality (IAQ) and thermal comfort are important determinants of occupant health and well-being, particularly in tropical institutional buildings where high temperature and humidity create persistent challenges for ventilation and moisture control. This study assessed IAQ and thermal conditions in four functional spaces, including a dental room, pharmacy, meeting room, and staff toilet, at Pusat Sejahtera, Universiti Sains Malaysia Engineering Campus. Field measurements were conducted over four weekdays during normal operating hours. Particulate matter (PM_1, $PM_{2.5}$ and PM_{10}), volatile organic compounds (VOCs), air temperature, and relative humidity (RH) were monitored using portable instruments. The meeting room recorded the highest mean PM_{10} concentration (46.88 μg/m³) and the highest short-term maximum value (219.5 μg/m³), whereas the staff toilet exhibited the highest mean VOC concentration (40.59 ppm). One-way ANOVA revealed significant differences among rooms for PM_1, $PM_{2.5}$ PM_{10}, and VOC concentrations ($p < 0.001$). Room type had the strongest influence on PM_{10} concentrations ($\eta^2 = 0.325$), followed by VOC concentrations ($\eta^2 = 0.126$). Mean indoor temperatures ranged from 27.17 to 28.96 °C, while RH ranged from 73.06% to 76.66%; both parameters were outside the recommended ranges specified in the Malaysian Industry Code of Practice on Indoor Air Quality. The results demonstrate that indoor environmental conditions varied substantially among functional spaces, with the meeting room and staff toilet representing the principal pollutant hotspots. These findings support the implementation of room-specific ventilation improvement, humidity control, targeted IAQ monitoring, and low-emission source-management strategies in tropical university healthcare facilities.

Keywords: Environmental monitoring; indoor pollutants; healthcare buildings; relative humidity; ventilation

AICCE 26-0035

SUSTAINABILITY ASSESSMENT APPROACHES FOR INFRASTRUCTURE PROJECTS: A CRITICAL REVIEW WITH CASE STUDIES ON HIGHWAYS AND BRIDGES

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Abstract

Sustainability has become a fundamental objective in infrastructure development due to increasing concerns regarding climate change, resource depletion, environmental degradation, and long-term socio-economic development. Highways and bridges are among the most resource-intensive infrastructure assets and significantly influence environmental quality, economic growth, and social wellbeing throughout their life cycle. Consequently, numerous sustainability assessment approaches have been developed to evaluate infrastructure performance during planning, design, construction, operation, maintenance, and end-of-life stages. This review critically examines contemporary sustainability assessment approaches applied to highway and bridge projects. The paper compares Life Cycle Assessment (LCA), Life Cycle Cost Analysis (LCCA), Life Cycle Sustainability Assessment (LCSA), Multi-Criteria Decision Analysis (MCDA), Environmental Impact Assessment (EIA), and internationally recognized infrastructure sustainability rating systems including Envision, CEEQUAL, Infrastructure Sustainability and BCA Green Mark. Case studies from developed and developing countries are discussed to illustrate practical implementation. The review identifies current limitations, including inconsistent sustainability indicators, inadequate integration of social dimensions, insufficient digitalization, and limited adaptation to developing-country contexts. Finally, a conceptual framework integrating Building Information Modelling (BIM), Digital Twins, Geographic Information Systems (GIS), Internet of Things (IoT), and Artificial Intelligence (AI) is proposed to improve future sustainability assessments for highways and bridge infrastructure.

Keywords: Infrastructure Sustainability, Life Cycle Assessment, Highway Engineering, Bridge Engineering, Multi-Criteria Decision Analysis

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FLEXURAL BEHAVIOUR OF REINFORCED CONCRETE BEAMS INCORPORATING FOUNDRY SAND AS FINE AGGREGATE REPLACEMENT

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Abstract

This study investigates the mechanical, elastic, and flexural responses of reinforced concrete incorporating waste foundry sand (WFS) as a partial and full replacement for natural fine aggregates. To evaluate the influence of WFS on material behaviour and beam performance, five concrete mixes were evaluated: a control mix containing 0% WFS and four modified mixes with 25%, 50%, 75%, and 100% replacement of river sand by waste foundry sand. The experimental program included the evaluation of the modulus of elasticity, load-carrying capacity, first crack load, load-deflection response, stiffness, toughness, crack pattern, and failure mode. A life cycle assessment (LCA) and machine learning were conducted to evaluate the environmental impact of concrete mixes containing waste foundry sand. The results demonstrate that the incorporation of WFS significantly influences both the fresh and hardened concrete behaviour because of its finer grading, high silica content, and residual binder coatings. At moderate replacement levels, WFS improved particle packing and enhanced the bond between the cement paste and aggregate, which contributed to improved crack resistance and a more stable flexural response. Beam testing showed that the mix containing 50% WFS exhibited the most balanced structural performance, with improved first-crack load, competitive ultimate load, enhanced stiffness, and better energy absorption compared with the control beam. At higher replacement levels, the benefits were reduced by increased water demand and reduced workability, which influenced the strength development and deflection behaviour. The findings demonstrate that waste foundry sand can be a sustainable and effective alternative to natural fine aggregates in reinforced concrete beams when an optimum replacement ratio with an appropriate mix design and quality control is achieved.

Keywords: Fine Aggregate Replacement; Flexural Behaviour; Reinforced Concrete Beams; Stiffness; Sustainable Concrete; Toughness; Waste Foundry Sand, life cycle analysis, machine learning

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STRESS-REGIME-SPECIFIC MECHANICAL PERFORMANCE AND CARBON SUSTAINABILITY OF ADVANCED POZZOLANIC CEMENTITIOUS SYSTEMS IN UHPFRCC

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Abstract

Decarbonizing ultra-high-performance fiber-reinforced cementitious composites (UHPFRCC) requires reconciling cementitious binder efficiency with multimodal mechanical performance and embodied carbon constraints. This study evaluates Portland cement systems incorporating pozzolanic supplementary cementitious materials (SCMs) through an experimentally grounded, multi-response framework integrating fresh-state workability, hardened-state resistance, and carbon intensity. The assessment interrogates composition-sensitive performance interdependencies, loading-mode specificity, and the non-equivalence of mechanical strength descriptors under distinct stress regimes. Particular emphasis is placed on cross-property compatibility and the competing implications of pozzolanic binder substitution for processability, strength retention, and carbon efficiency. Rather than treating replacement level or compressive resistance as isolated indicators, the analysis considers the coupled performance domain governing mechanical functionality and environmental burden. It further distinguishes nominal carbon savings from binder modifications that satisfy multiple mechanical performance requirements concurrently. This integrated approach elucidates formulation-dependent trade-offs and establishes a performance-constrained basis for assessing pozzolanic SCM incorporation, supporting rational binder engineering in structurally demanding, resource efficient, lower-carbon UHPFRCC.

Keywords: UHPFRCC; Pozzolanic Supplementary Cementitious Materials; Advanced Cementitious Binder Engineering; Mechanical Performance; Sustainability; Embodied Carbon.

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STRUCTURAL PERFORMANCE OF BUILT-UP COLD-FORMED STEEL COMPRESSION MEMBER ATTACHED WITH TIMBER PALLETS

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Abstract

Cold-formed steel (CFS), or identified as a thin-walled structure is a construction steel-based solid material which always is utilised as a non-structural and structural component in buildings. Due to its slender and thin sections, CFS sections often fail when proposed as flexural or compression members, which may lead to issues like roof truss collapse and other similar problems. Flexural members or beams and compression members or columns of CFS become unstable structures when the section is subjected to local, distortional, global and lateral-torsional buckling or web-crippling phenomena. Therefore, CFS available in the market, especially open channel or unsymmetrical sections that are continually used in the roof truss system is selected, and the structural performance of the built-up CFS compression member section when attached with timber pallets is determined. Thus, the built-up CFS flexural and compression member section can eliminate the deformation or displacement of flange and web elements, and overall, out-of-plane movement. The main objective of this study is to determine the structural performance of the CFS compression member section with timber pallets under axial compression load. The experimental activity of this study is divided into three parts. The first part is to determine the material properties of the CFS, second part is to determine the mechanical properties of the bolt as a fastener and the last part classifies the main activity for determining the structural performance of built-up CFS compression members attached with timber pallets. The highest ultimate load for CFS channel section attached with timber pallets is CFS150, built-up CFS in back-to-back profile attached with timber pallets is CFSB2B350 and built-up CFS in face-to-face profile attached with timber pallets is CFSF2F250. The range of ultimate load ratio of 0.98-1.12 when compared between the experimental and theoretical analyses.

Keywords: Cold-formed Steel, Built-up Section, Compression Member, Timber Pallets, Buckling

AICCE 26-0041

EFFECT OF CARBON FIBRE LENGTH ON THE MONOTONIC LATERAL BEHAVIOUR OF REINFORCED CONCRETE COLUMNS

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Abstract

Reinforced concrete (RC) columns are critical structural members that transfer loads from the superstructure to the foundation. Incorporating chopped carbon fibres into concrete may improve the lateral performance of RC columns by enhancing strength, stiffness, deformation characteristics, and crack resistance. This study experimentally investigates the effect of carbon fibre length on the monotonic lateral behaviour of one-third-scale RC columns incorporating 0.6% chopped carbon fibres with lengths of 6, 9, and 12 mm. The specimens were subjected to constant axial loading and displacement-controlled monotonic lateral loading at a rate of 3 mm/min. Their performance was evaluated in terms of lateral load-drift response, peak load, displacement ductility ratio, secant stiffness, crack development, and failure mechanism. The CF6 specimen achieved the highest peak load of 15.2 kN, representing a 10.8% increase over the Control specimen, and recorded the highest peak drift ratio of 1.65%. The CF9 specimen achieved the highest displacement ductility ratio of 1.73 and initial secant stiffness of 2.98 kN/mm and exhibited the highest first-crack load with relatively controlled crack development. All specimens exhibited predominantly flexural behaviour without significant concrete crushing, spalling, or diagonal shear cracking. Overall, the 6 mm carbon fibres were more effective in improving lateral strength, whereas the 9 mm fibres provided greater benefits in terms of deformation characteristics, stiffness, and crack control.

Keywords: Carbon fibre-reinforced concrete; reinforced concrete columns; monotonic lateral loading; lateral load capacity; displacement ductility ratio; crack development

AICCE 26-0044

A DUAL-BRANCH FRAMEWORK FOR ROOF DAMAGE ESTIMATION USING POST-DISASTER UAV IMAGERY

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Abstract

Post-disaster UAV and aerial imagery from wind-damage investigations in China provides rapid documentation of roof damage, but a meaningful damage ratio requires separate estimates of damaged area and the complete roof area before the observed material loss. Using only the remaining visible roof as the denominator can overestimate severity when material loss is extensive. This study presents a dual-branch framework for projected-image roof damage ratio estimation. One branch reconstructs the complete pre-damage roof extent through target-domain roof segmentation, conservative instance recovery, and selective amodal refinement. The other segments severe roof material loss. The outputs are combined only during pixel-based ratio calculation. On Roof-Test, which contains 16 images and 36 ground-truth roofs, the complete-roof segmenter achieved a mean matched intersection over union (IoU) of 0.8194 and a mean matched area relative error of 0.1204. On the 68-image Roof-Dev set, grouped out-of-fold evaluation gave a matched IoU of 0.8071 and a matched area relative error of 0.1642 after selective refinement. The damage branch was evaluated on an independent 69-image target-domain set, with one target roof per image and ground-truth complete roofs used as fixed denominators. Its damage-ratio mean absolute error was 3.96 percentage points (pp), the median absolute error was 1.62 pp, and 92.8% of evaluated roofs were within 10 pp. This evaluation isolates numerator error; broader independent validation with both branches predicted remains necessary.

Keywords: roof damage ratio, UAV imagery, post-disaster assessment, complete roof reconstruction, damage segmentation

AICCE 26-0045

AERODYNAMIC INTERFERENCE EFFECTS BETWEEN TWO HIGH-RISE BUILDINGS UNDER DOWNBURST-LIKE WIND FIELDS

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Abstract

Downburst wind fields (DWFs) are characterized by strong near-ground wind structures, which may produce wind loads on high-rise buildings that differ significantly from those generated under conventional wind fields (CWFs). However, existing studies have mainly focused on isolated buildings, while the aerodynamic interference effects between adjacent buildings under DWF conditions remain insufficiently understood. In this study, wind tunnel tests were conducted to investigate the aerodynamic interference effects on a principal high-rise building subjected to DWFs. The effects of interference spacing and relative position on global wind loads, local wind pressures, and wind pressure statistical characteristics were systematically examined and compared with those under CWF conditions. The results show that the wake shielding effect induced by the interfering building is more significant under DWF conditions. Even when the interference spacing reaches eight times the building width, the along-wind base bending moment is still reduced by 46%. In addition, the interference effects on fluctuating wind forces and bending moments exhibit obvious asynchronous variations. Compared with CWFs, the unique wind-speed profile of DWFs leads to significant differences in the building surface wind pressure distribution and interference decay characteristics. Under DWF conditions, high-value fluctuating wind pressures are mainly concentrated in the middle and lower regions of the windward façade. And when the interfering building is located at x/B = 4~5, the local fluctuating drag coefficient exhibits its maximum amplification in the middle region of the principal building. Moreover, the probability density distributions of wind pressure in these regions exhibit pronounced non-Gaussian characteristics, indicating stronger instantaneous wind pressure fluctuations and a higher probability of extreme pressure events. Based on the experimental results, an empirical interference model applicable to DWFs is further proposed. The findings provide useful references for the wind-resistant design and cladding safety assessment of high-rise building clusters under downburst winds.

Keywords: Downbursts; Interference effects; High-rise buildings; Wind tunnel testing; Wind loads

AICCE 26-0046

NUMERICAL ANALYSIS OF MOTION CHARACTERISTICS OF HAILSTONES DRIVEN BY DOWNBURST OUTFLOW

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Abstract

Downbursts can generate intense near ground horizontal outflows, while severe convective weather is often accompanied by hail, making the conventional assumption of vertical hailfall inadequate to fully represent the motion and hazard-causing process of wind-driven hail. Although wind-driven hail may cause significant impacts on building envelopes, the influence of horizontal outflows on hailstone motion characteristics still lacks quantitative investigation. In this study, computational fluid dynamics (CFD) is first used to reproduce the steady downburst-like outflow field generated by an active-controlled multi-blade system (AMBS), and the model-scale wind field is converted to prototype scale according to a geometric scale ratio of 1:400 and a velocity scale ratio of 1:4. A three-dimensional wind field is then reconstructed in MATLAB, and the hailstone trajectory equations are solved. The results show that hailstone size governs the motion response mainly through the area-to-mass ratio, falling inertia, and wind-field exposure time. As the diameter increases from 1 cm to 5 cm, the flight time decreases from 26.89 s to 15.27 s, and the along-wind displacement decreases from 984.32 m to 455.37 m, a reduction of 53.7%; the maximum along-wind velocity varies only within 43.34-44.26 m/s, whereas the magnitude of the vertical falling velocity increases from 14.96 m/s to 29.32 m/s. The descent angle decreases from approximately 67.15° to 54.52°, and the total landing momentum increases from approximately 0.017 kg·m/s to 2.96 kg·m/s. The results reveal the motion characteristics of hailstones of different sizes in a downburst horizontal outflow field and provide a dynamic basis for subsequent analyses of hail impact response on building facades and building-envelope vulnerability.

Keywords: downburst outflow, wind-driven hail, motion trajectory, CFD

AICCE 26-0047

POST-EVENT FORENSIC INVESTIGATION OF TORNADO IMPACT ON HIGH-RISE BUILDING CLUSTER

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Abstract

This paper presents a forensic investigation of the tornado that attacked Dongming, China, on July 5th 2024, based on an extensive post-disaster field survey, with a focus on its impact on high-rise building cluster. The tornado reached EF3 intensity according to the EF-scale and its adaptations, with a path 12 km in length and 690 m in maximum width. Analysis of substantial facade damage observed from the cluster revealed significant wind interference effects. The spatial distribution and damage characteristics of the high-rise building facades were examined in detail, with emphasis on building orientation, aerodynamic interference, and wind-borne debris impact. Particular emphasis was placed on wind-borne debris, with lift-off speeds and impact trajectories analyzed based on field observations. The findings highlight the correlations of the tornado-induced damage with building cluster layout, envelope vulnerability, local wind amplification, debris motion, etc. This study aims to present valuable insights into the effects of intense tornadoes on high-rise building clusters in urban areas, providing strategies to enhance urban resilience against extreme wind events.

Keywords: Tornadoes; Field survey; Wind-induced disaster; Enhanced Fujita Scale; Wind-borne debris

AICCE 26-0048

MECHANICAL PROPERTIES AND PERFORMANCE OF CRUMB RUBBER AS PARTIAL REPLACEMENT FOR FINE AGGREGATE IN CONCRETE

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Abstract

This study evaluates the physical and mechanical performance of sustainable concrete incorporating crumb rubber as a partial volumetric replacement for natural fine aggregate, with emphasis on potential transport infrastructure applications. Natural river sand was replaced by crumb rubber at 0%, 10%, 20%, 30% and 40% by volume under water-to-cement (w/c) ratios of 0.35 and 0.45. A fixed 30% Ground Granulated Blast-furnace Slag (GGBS) replacement of Ordinary Portland Cement was used for the rubber-modified and GGBS-control mixtures. Specimens were continuously cured in tap water and tested at 7 and 28 days for slump, hardened density, water absorption and compressive strength, while splitting tensile strength was determined at 28 days in accordance with BS EN 12390. Increasing crumb rubber content reduced workability, density and mechanical strength. At 28 days, SSD density decreased from 2255 to 2142 kg/m³ for the 0.35 w/c series and from 2259 to 2059 kg/m³ for the 0.45 w/c series. For w/c = 0.35, compressive strength decreased from 56.1 MPa at 0% rubber to 40.4, 30.5, 24.1 and 18.6 MPa at 10%, 20%, 30% and 40% replacement, respectively. Water absorption generally stabilised or declined by 28 days, reflecting continued GGBS-related matrix refinement. Overall, 10–20% crumb rubber at w/c = 0.35 retained useful mechanical capacity for low-load structural and semi-structural applications, whereas 30–40% replacement provided lower-density, more ductile concrete suitable for non-structural and impact-attenuating components.

Keywords: crumb rubber, rubberised concrete, fine aggregate replacement, GGBS, mechanical properties

AICCE 26-0049

MOTOR VEHICLE OVERTAKING CYCLISTS: A SYSTEMATIC REVIEW FROM NATURALISTIC STUDIES

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Abstract

Cyclists are exposed to risks during overtaking manoeuvres in mixed-traffic environments. Although naturalistic and quasi-naturalistic studies have improved understanding of cyclist– motorist interactions, evidence remains fragmented across behavioural, environmental, and cyclist-related factors. This systematic review synthesises naturalistic findings on motorists' overtaking behaviour and the factors influencing cyclists' safety margins. Following the ROSES protocol and the PICo framework, a comprehensive search was conducted across five databases using combinations of "cyclist", "overtaking", and "naturalistic study". Thirty peer-reviewed engineering studies were appraised using the Mixed Methods Appraisal Tool. The review identifies three groups of influencing factors: motorists' overtaking behaviour, road and traffic conditions, and cyclist characteristics. Across the reviewed studies, unsafe overtaking was consistently associated with higher vehicle speeds, longer durations, shorter passing distances, larger vehicles, and overtaking without lane occupation. Conversely, wider lanes or shoulders, clear road markings, and separated cycling facilities increase passing distance and encourage safer overtaking. Environmental constraints such as narrow roads, no shoulder areas, high traffic density, oncoming traffic, and parked vehicles elevate the probability of close overtaking. Additionally, assertive lane positioning, group riding, and visible cyclist characteristics enhance safety during the manoeuvre. The findings collectively enhance comprehension of cyclist–motorist dynamics during overtaking, targeting improved cycling environments.

Keywords: Cyclist, Naturalistic study, Overtaking, Risk perception, Systematic literature review.

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EFFECTS OF SHORT-TERM AGEING ON THE HIGH-TEMPERATURE PERFORMANCE GRADE AND NON-RECOVERABLE CREEP COMPLIANCE OF POLYURETHANE MODIFIED BITUMEN

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Abstract

Thermo-oxidative short-term ageing (STA) during high-temperature plant production significantly affects the high-temperature rheology and non-linear creep response of modified bitumens. This study evaluates the impact of STA on the high-temperature performance grading (PG), non-recoverable creep compliance (J_{nr}), percent recovery (R), and stress sensitivity (Jnr-diff) of polyurethane-modified bitumen (PUMB) compared to unmodified base bitumen (BB). Short-term aged specimens were prepared using the Rolling Thin Film Oven (RTFO) procedure per ASTM D2872, after which high-temperature performance properties and non-linear viscoelastic behaviors were tested using a Dynamic Shear Rheometer (DSR) across 58 °C, 64 °C, and 70 °C via temperature sweep and Multiple Stress Creep Recovery (MSCR) at 0.1 kPa and 3.2 kPa stress levels. Temperature sweep results revealed that PUMB elevated the continuous high-temperature bitumen performance grade from PG 64 (BB) to PG 70 (PUMB), maintaining the rutting parameter (G*/ sin δ) well above the 2.2 kPa threshold post-aging up to 66 °C. The MSCR evaluation demonstrated that under 3.2 kPa heavy shear stress, PUMB-A achieved superior deformation resistance with a marked reduction in non-recoverable compliance ($J_{nr,3.2}$ = 0.015 kPa^{-1} at 70 °C) and maintained positive recovery values, whereas BB-A exhibited viscoplastic failure. Furthermore, PUMB-A displayed negative Jnr-diff values −92.18% at 64 °C and 70 °C, confirming a strain-hardening mechanism activated by the combined effects of oxidative stiffening and the cross-linked PU polymer network under high stress. Overall, PU modification effectively mitigates short-term ageing susceptibility and imparts exceptional resistance to high-temperature rutting under heavy traffic loads.

Keywords: Polyurethane modified bitumen (PUMB), Short-term ageing (STA), Multiple Stress Creep Recovery (MSCR), Non-recoverable creep compliance, performance grading

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SCHMIDT HAMMER ASSESSMENT OF ROCK HARDNESS VARIABILITY AT A GRANITE QUARRY IN MALAYSIA

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Abstract

Granite is widely used as a construction aggregate, and variations in rock hardness caused by weathering can influence its engineering characteristics and quarry assessment. This study evaluates the spatial variability of granite rebound hardness across different quarry slopes and weathering grades at Kuad Quarry, Penang, Malaysia, using an L-type Schmidt rebound hammer. A total of 128 measurement points were established across six exposed granite slopes, with 10 rebound readings recorded at each point and averaged to obtain a representative rebound value. The rebound values ranged from 14.6 to 49.2, with an overall mean of 34.0, standard deviation of 6.3, and coefficient of variation of 18.5%. Mean rebound values also varied between slopes, ranging from 29.8 at Slope 5 to 39.1 at Slope 2. A clearer trend was observed across weathering grades, where mean rebound values decreased from 43.8 for Grade II to 35.1 for Grade III and 24.5 for Grade IV, representing an approximately 44% reduction from Grade II to Grade IV. These findings indicate that weathering condition may be more closely associated with rebound hardness than slope location alone. The Schmidt hammer therefore provides a rapid and non-destructive method for identifying spatial variations in granite surface hardness and can complement visual weathering classification for site-specific quarry assessment.

Keywords: Schmidt hammer, rebound hardness, rock strength variability, non-destructive testing, sustainable construction

AICCE 26-0053

ACCLIMATION CHARACTERISTICS OF SBR-MBBR SYSTEMS WITH DIFFERENT K1 FILLING RATIOS TREATING REAL AQUACULTURE WASTEWATER

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Abstract

Real aquaculture wastewater can exhibit batch-to-batch variation because its characteristics reflect routine aquaculture operations rather than fixed influent conditions. This study characterized the acclimation behavior of two parallel sequencing batch moving bed biofilm reactors (SBR-MBBRs) treating real tilapia recirculating aquaculture system (RAS) wastewater under naturally variable influent conditions. Two reactors were operated with pre-colonized K1 carriers at filling ratios of 30% in Reactor 1 (R1) and 50% in Reactor 2 (R2), while other operating conditions were kept consistent. During Batch 0–14, fresh influent and reactor effluent were monitored for pH, dissolved oxygen (DO), temperature, ammonia nitrogen (NH_3-N), and selected chemical oxygen demand (COD). Fresh influent NH_3-N ranged from 1.20 to 3.18 mg L^{-1}, while effluent NH_3-N ranged from 0.96 to 2.79 mg L^{-1} in R1 and from 0.81 to 3.04 mg L^{-1} in R2. Effluent NH_3-N showed batch-to-batch variation with broadly similar temporal patterns in both reactors. COD also varied across the sampled batches, ranging from 41 to 69 mg L^{-1} in R1 and 44 to 67 mg L^{-1} in R2, compared with 54– 70 mg L^{-1} in the fresh influent. Effluent pH was generally lower than that of the fresh influent, while DO and temperature remained relatively stable. Because 50% of the working volume was exchanged per cycle and influent characteristics varied naturally between batches, direct cycle-specific removal efficiency was not determined. The results provide a preliminary characterization of SBR-MBBR acclimation under real, naturally variable aquaculture wastewater conditions, while longer-term operation is required to assess sustained differences between the two K1 filling ratios.

Keywords: Recirculating aquaculture system (RAS) wastewater, Sequencing batch reactor (SBR), Moving bed biofilm reactor (MBBR), K1 filling ratio, Acclimation

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STRENGTH AND SURFACE ABSORPTION OF MODIFIED PHOSPHOGYPSUM MORTARS: TOWARD A RAPID INDICATOR FOR DATA-DRIVEN QUALITY ASSESSMENT

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Abstract

This study investigated the mechanical performance and surface water absorption of phosphogypsum (PG) mortar modified separately with palm fiber (PF) and graphene oxide (GO). A sequential experimental framework was adopted, beginning with preliminary screening of the PG:sand ratio, standard consistency, flowability, setting behavior, and retarder suitability to establish a reproducible reference mortar. A PG:sand mass ratio of 1:1 and an amino-acid-based retarder (PE) were selected for the subsequent modifier series. PF contents of 0.1–0.7% were investigated at fiber lengths of 2, 4, and 8 cm, while GO contents of 0.1–0.7% were evaluated independently. Flexural, compressive, and tensile strengths were determined, and 28-day specimens were further assessed using the 10-min Initial Surface Absorption Test (ISAT). Within the investigated range, the best-performing PF formulation contained 0.7% PF with a fiber length of 4 cm, achieving 28-day flexural, compressive, and tensile strengths of 8.8, 30.6, and 3.60 MPa, respectively, together with the lowest ISAT value of 0.12 mL/(m²·s). The best-performing GO formulation contained 0.5% GO, reaching corresponding strengths of 6.0, 25.7, and 2.96 MPa and an ISAT value of 0.23 mL/(m²·s). Across all PF- and GO-modified mixtures, 28-day compressive strength exhibited a strong inverse power-law relationship with 10-min ISAT, described by $fc=17.599I^{-0.266}$ with $R^2=0.9193$. The results demonstrate that PF provided the greater mechanical enhancement, while 10-min ISAT showed potential as a rapid complementary indicator of later-age compressive performance in modified PG mortar. Because the 10-min ISAT is non-destructive and rapid compared with 28-day strength testing, the derived relationship offers a practical basis for early, data-driven quality screening of modified PG mortar a capability relevant to faster, more automatable quality-assurance workflows in construction practice.

Keywords: Phosphogypsum, Palm fiber, Graphene oxide, Initial surface absorption, Compressive strength.

AICCE 26-0056

DATA-DRIVEN SAFETY ASSESSMENT OF MALAYSIA'S EXCLUSIVE MOTORCYCLE LANES: ADVANCING RESILIENT AND SUSTAINABLE ROAD INFRASTRUCTURE

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Abstract

Motorcyclists remain among Malaysia's most vulnerable road users, and exclusive motorcycle lanes (EMCLs) are intended to reduce their exposure to mixed, higher-speed traffic. However, deterioration, roadside hazards, weak delineation and constrained geometry can compromise the intended protection and discourage use. This study evaluates five Malaysian EMCLs: KESAS Expressway E5, Guthrie Corridor Expressway E35, Butterworth– Kulim Expressway E15, Sultan Abdul Halim Muadzam Shah Bridge E28 and Federal Route 2 FT002, using the International Road Assessment Programme (iRAP) methodology. Geo-referenced roadway imagery was collected, more than 50 road attributes were coded at 100 m intervals, and data were analysed in ViDA to generate motorcyclist Star Rating Scores and ratings. Approximately 200 km of EMCLs were assessed. E35 performed best, with 83% rated 3-star or better, followed by E5 at 61%, FT002 at 52%, and E15 and E28 at 41% each. Across the assessed network, about 40% was rated 1-star or 2-star, while no route achieved a 5-star segment; only E35 and FT002 contained 4-star segments. Recurring deficiencies included unprotected barrier ends and rigid roadside objects, inadequate shoulders and recovery space, poor pavement condition, weak delineation, and entry–exit risks. A risk-based investment framework is proposed: first, raise high-volume 1-star and 2-star sections to at least 3-star using high-return measures; next, close short, low-rated gaps to create continuous, safer corridors; and then undertake geometric, motorcyclist-friendly barrier, and intelligent transport system upgrades. The findings show how proactive, attribute-based assessment can guide infrastructure investment before further crashes occur, strengthen network resilience, and support sustainable protection of vulnerable road users.

Keywords: exclusive motorcycle lanes; star rating; motorcycle safety; resilient infrastructure; sustainable transport.

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MAPPING THE EVOLUTION OF MOTORCYCLE SAFETY AND ROAD INFRASTRUCTURE RESEARCH

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Abstract

This study maps knowledge development in motorcycle safety and road infrastructure, identifies intellectual streams, and establishes an integrated infrastructure-oriented research agenda. Bibliometric performance analysis and science mapping were applied to journal articles indexed in Scopus, published from 1977 to 2026, and retrieved on 16 July 2026. Publication and citation indicators examined the growth and influence of the knowledge base, while author-keyword co-occurrence and temporal overlay analyses identified its intellectual structure and evolving priorities. Findings were interpreted through a Safe System lens to assess the position of road infrastructure within motorcycle safety research. The literature has expanded substantially, indicating a growing but still developing domain. Four (4) interconnected streams were identified: motorcycle safety, behaviour and infrastructure; mixed-traffic interactions and surrogate safety; crash severity and heterogeneity modelling; and road-safety analytics. The field has shifted from conventional crash-based and statistical approaches towards surrogate safety assessment, infrastructure intervention evaluation, advanced heterogeneity modelling and data-driven methods. However, infrastructure-related knowledge remains dispersed rather than forming an integrated evidence base for designing and evaluating motorcycle-specific infrastructure. The study is limited to journal articles indexed in Scopus and is therefore influenced by database coverage, search-term selection and author-keyword practices. Future research should integrate infrastructure design, mixed-traffic interactions, proactive safety indicators and simulation-based evaluation to determine when and where motorcycle-specific interventions are effective. By combining performance analysis, science mapping and Safe System interpretation, this study explains how the knowledge base has evolved, where fragmentation persists, and how an integrated infrastructure-oriented research agenda can be more effectively advanced.

Keywords: Motorcycle safety, Road infrastructure, Bibliometric analysis, Science mapping, Safe System

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MECHANICAL PERFORMANCE AND FAILURE MECHANISMS OF SCREW-CONNECTED TIMBER–CONCRETE COMPOSITE CONNECTIONS

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Abstract

This study investigates the mechanical response and failure mechanisms of screw-connected timber–concrete composite (TCC) connections under lateral loading, focusing on the effects of concrete strength and screw inclination angle. Nine specimens with concrete strengths of 20, 25, and 30 MPa and screw angles of 45°, 60°, and 90° were evaluated using global load– displacement responses. Peak shear force capacity, peak displacement, displacement at $0.4F_{max}$, and secant stiffness were used as the main performance indicators. The 25 MPa group achieved the highest average peak shear force capacity of 53.886 kN, whereas the 30 MPa group showed the strongest initial deformation resistance. The 90° configuration provided the highest average peak shear force capacity of 62.503 kN, while the 45° configuration exhibited the highest initial stiffness. Post-test observations indicated composite failure involving timber embedment and tearing, concrete crushing and breakout, and screw withdrawal, bending, or fracture. Overall, concrete strength mainly affected local confinement, whereas screw inclination altered the balance between withdrawal and bearing actions, demonstrating that connection performance should be assessed comprehensively in terms of strength, stiffness, deformation, and failure behavior.

Keywords: Timber–concrete composite; Screw connection; Concrete strength; Screw inclination angle; Shear force capacity; Stiffness; Failure mechanism

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SELF ORGANIZING MAPS FOR MACHINE LEARNING-BASED PREDICTION OF RECYCLED ASPHALT PROPERTIES

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Abstract

Laboratory characterization of asphalt mixtures is time-consuming and costly, and testing every possible combination of binder, aggregate and additive is impractical. This study investigates the Self-Organising Map (SOM), an unsupervised neural network, for predicting asphalt mix properties and supporting sustainable mix design. Key input and output parameters were first identified by relating pavement distress types to mixture properties under Malaysian conditions. SOM models were then built in parallel in Python and MATLAB using existing mix design data, and Python was adopted data handling, configuration and debugging. The model was extended to three asphalt categories: reclaimed asphalt pavement, RAP; open-graded asphalt with crushed glass waste; and asphalt with crushed glass waste. This model was given two functions: forward prediction of volumetric and Marshall properties from mix parameters, and inverse suggestion of feasible input ranges from target outputs. The RAP model was selected for final development, and its dataset was expanded from 30 to 173 mixes using data from 16 published studies. Under a train–test split (138 training and 35 testing mixes), six successive refinement stages (prediction neighbourhood radius, distance-weighted prediction, hyperparameter tuning, repeated validation, input selection and final hyperparameter refinement) increased the test R^2 from 0.119 to 0.586, reduced the mean absolute error from 1.92 to 1.12 and the root mean squared error from 3.47 to 2.20, and reduced the quantisation and topographic errors from 0.159 to 0.050 and from 0.051 to 0.015, respectively. Performance was sensitive to the train–test split, and the model is limited by the small dataset, its RAP-specific scope and the indirect predictive nature of SOM. The results indicate that SOM can serve as an interpretable, exploratory decision-support tool that narrows the range of mixes requiring laboratory testing.

Keywords: Machine learning, Self-organizing map, Reclaimed asphalt pavement, Asphalt mix design, Inverse prediction

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POST-CRASH INFRASTRUCTURE SAFETY ASSESSMENT AND ENGINEERING TREATMENT PRIORITISATION FOR THE GERIK–JELI CORRIDOR, MALAYSIA

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Abstract

Mountainous two-lane rural corridors present substantial road-safety challenges because demanding horizontal alignment, restricted sight distance, roadside hazards, degraded traffic-control devices, and limited roadside recovery space can increase the likelihood and severity of loss-of-control, head-on, and run-off-road crashes. This study undertook a post-crash infrastructure safety assessment of the Gerik–Jeli corridor on Federal Route FT004, Malaysia, following renewed public concern after a fatal bus crash involving Universiti Pendidikan Sultan Idris students in 2025. The study does not reconstruct the crash or determine legal responsibility; instead, it integrates police-reported crash records for 2018–2020, official blackspot records for 2013–2024, historical iRAP Star Rating data from 2016, road safety inspection findings, and site-specific traffic and speed observations. A total of 304 crashes were recorded, including 91 fatal crashes. Side collisions, head-on collisions, and run-off-road/loss-of-control crashes were prominent crash configurations. The spatial overlay identified locations where recent crash concentrations coincided with historic blackspots, while the 2016 iRAP assessment indicated that only a small proportion of the route was rated at three stars or above. The road safety inspection identified restricted curve visibility, degraded road markings, ineffective reflector systems, damaged safety barriers and terminals, deteriorated chevrons, pavement distress, and lack of lighting at the inspected high-risk location. Site-specific observations also showed that 85th-percentile operating speeds exceeded the posted 60 km/h speed limit at selected approaches. The findings support a targeted engineering response comprising immediate maintenance, short-term delineation and curve-warning improvements, and medium-term infrastructure upgrading. Priority treatments include renewal of high-retroreflectivity road markings, raised pavement markers, replacement or cleaning of reflectors and chevrons, repair of damaged barrier components and terminals, pavement rehabilitation, and site-specific assessment of barrier upgrading and lighting. Because time-specific traffic-exposure data were unavailable, the lighting-condition analysis compares crash-severity distributions and does not estimate relative daytime or nighttime crash risk.

Keywords: road safety, crash analysis, iRAP, road safety inspection, mountainous roads

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EVALUATION OF BAMBOO ACTIVATED CARBON FOR FIXED-BED LANDFILL LEACHATE TREATMENT

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Abstract

Landfill leachate contains complex organic matter, colour-causing substances, suspended solids, and other contaminants that require treatment before discharge. This study evaluated commercially available bamboo activated carbon (BAC) as an adsorbent for landfill leachate treatment using a laboratory-scale fixed-bed column. The raw leachate was characterized for biochemical oxygen demand, chemical oxygen demand (COD), colour, turbidity, pH, and suspended solids (SS). BAC was examined before and after filtration using scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX). The column was operated using a one-factor-at-a-time approach by varying BAC bed depth, flow rate, and organic loading condition. Bed depths of 10, 20, and 30 cm and flow rates of 5 and 10 mL/min were tested. The organic loading study compared 100% raw leachate with 30% leachate and 70% distilled water. The selected operating condition was a 20 cm BAC bed, 5 mL/min flow rate, and 30% leachate with 70% distilled water. Under this condition, maximum removal efficiencies of 67.98% COD, 62.41% colour, 46.71% turbidity, and 47.43% SS were obtained. SEM showed that the used BAC surface became more covered and compact after filtration, while EDX showed carbon increasing from 57.72% to 75.87%. Breakthrough curves indicated delayed saturation at the lower flow rate and lower organic loading. The Thomas and Yoon–Nelson models generally described the COD breakthrough data well, although the diluted condition gave a weaker model fit. The results indicate that BAC has potential as a renewable polishing adsorbent for lower-strength or pre-treated landfill leachate.

Keywords: Bamboo activated carbon, Fixed-bed adsorption, Landfill leachate, Breakthrough curve, COD removal

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STRESS-STRAIN PREDICTION OF THICK-WALLED COLD-FORMED STEEL (CFS) STRUCTURES BASED ON ABAQUS: A COMPARATIVE ANALYSIS FROM THE PERSPECTIVE OF MACHINE LEARNING ALGORITHM EVOLUTION

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Abstract

Thick-walled Cold-formed Steel (CFS) structures have gained widespread adoption in modern construction due to their lightweight properties and high strength-to-weight ratios. However, predicting structural responses under cyclic loading conditions, such as wind and seismic loads, remains challenging for traditional analytical methods. This study presents a comprehensive comparison from a historical evolution perspective of three representative machine learning algorithms for stress-strain prediction in thick-walled CFS roof structures. Using ABAQUS finite element software, ten distinct geometric configurations of thick-walled CFS roof structures were modeled under cyclic loading conditions ($\pm 5\times10^6$N, 0.5Hz, 4.5 cycles), generating a comprehensive dataset of 222,528 stress-strain data points. Three algorithms representing different machine learning eras were implemented: Enhanced Random Forest representing traditional ensemble learning, Deep MLP （Multi-Layer Perceptron） representing the deep learning renaissance, and TabNet exemplifying modern attention-based architectures. Strict ModelID-based data splitting was employed to prevent data leakage, with 70% for training and 30% for testing. Results demonstrate significant performance variations: Deep MLP（Multi-Layer Perceptron） achieved the highest prediction accuracy (R^2 = 0.9332), followed by Enhanced Random Forest (R^2 = 0.9247), while TabNet showed moderate performance (R^2 = 0.8282) but superior interpretability through attention mechanisms. The historical evolution analysis reveals that algorithmic advancement follows a non-linear progression, with each era exhibiting distinct technical characteristics and engineering trade-offs. This research provides a systematic framework for algorithm selection in structural engineering applications, offering practical guidance for engineers to make informed decisions based on specific requirements rather than technological novelty alone.

Keywords: Thick-walled Cold-formed Steel (CFS), ABAQUS, machine learning evolution, algorithm comparison, structural prediction, cyclic loading

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RAINFALL RESPONSE OF INSTRUMENTED UNSATURATED SAND SLOPES UNDER DIFFERENT RAINFALL INTENSITIES AND INCLINATIONS

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Abstract

Rainfall infiltration changes the hydraulic conditions of unsaturated slopes, but the response varies with slope geometry and measurement position. This research used an instrumented laboratory model as well as numerical slope analysis to study sand slopes of angle 40° and 60° subjected to rainfall intensities of 60 and 80mm/h. The physical model consisted of an acrylic box measuring 1 m×1 m×1 m, a drip-type rainfall simulator, and a groundwater circulating system. All cases had a stage of equalization which was followed by six hours of rainfall followed by post rainfall monitoring. Tensiometers gauged pore-water pressure; time domain reflectometry probes measured the volumetric water content. The data from three locations of the equipment was used to make a comparison. The first important phenomenon observed during wetting is that the negative pore-water pressures at first moved towards 0.0 (some readings became even positive). After the rain occurrence, there are records where the pressure and water content fell, but not all four cases recovered. Numerical analyses of transient seepage in SEEP/W and Morgenstern–Price stability calculations in SLOPE/W. In all four cases, the reported stability curves dropped below a factor of safety equal to unity. The findings indicate that simultaneous monitoring of pressure and water content can enhance the understanding of wetting and drainage of a slope. The support for more investigation of the rainfall-induced instability is there among professionals but differences in initial conditions and laboratory to numerical scale don't allow for direct prediction of a field failure.

Keywords: Rainfall, Slopes, Sand, Suction, Monitoring

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THE APPLICATION OF KINGDOM OF SAUDI ARABIA'S DESERT SAND AS ADSORBENT ON METHYLENE BLUE REMOVALS

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Abstract

Methylene blue is one of the common dyestuffs that has been used in the textile industry. The wide application of it also leads to the elevated quantity released in nature through textile wastewater. The adsorption process has many advantages as instance low cost, low energy needed and less complex operation. The exploration of KSA's desert sand as an adsorbent gives more option in water treatment. Desert sand is considered cheap due to its availability. The particle size distribution shows that the KSA's particle size ranging from 0.6 to smaller than 0.063. This shows that the KSA's desert sand is very fine. KSA's desert sand has proven to be a good adsorbent in this study. The XRF analysis shows that the main elements in the KSA's desert sand are Si, Ca, and Al. Measurement of methylene blue's concentration is completed using Thermoscientific Genesys 30 Visible Spectrophotometer where the calibration curve is first established within the range of 1 to 15 mg/L with R^2 value at 99.7 %. The best removal occurred at the adsorbent dosage of 25 g, with the removal rate approximately 94 %. For agitation rate, the best setting based on this study is at 200 rpm. The removal rate is almost 95 %. Lastly, the optimum contact time in this study is 20 minutes, where the removal rate is as high as 100%. The observations of color change after the absorption experiments match the removal rate calculated from the value recorded by the spectrophotometer.

Keywords: Adsorption, Saudi sand, Methylene blue

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STUDY ON THE EVALUATION OF FLOATING WETLAND SYSTEM USING VETIVER GRASS FOR PAPER MILL WASTEWATER TREATMENT

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Abstract

The pulp and paper industry is one of the major industrial sectors that generates large volumes of wastewater containing high concentrations of organic pollutants, suspended solids, nutrients and oil and grease. Conventional treatment technologies are generally effective but often involve high capital costs, energy consumption and operational complexity. Floating Treatment Wetlands (FTWs) have emerged as an environmentally sustainable alternative that utilises aquatic plants and microbial activity for pollutant removal. This study evaluated the performance of a Vetiver-based FTW system in treating paper mill wastewater collected from Nibong Tebal Paper Mill Sdn. Bhd. (NTPM), Malaysia. The experimental system was operated under laboratory conditions for 28 days using lowland Vetiver grass (Chrysopogon zizanioides). Water quality was monitored weekly by analysing Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD_5), Total Ammoniacal Nitrogen (TAN), Total Suspended Solids (TSS), turbidity, oil and grease, pH and dissolved oxygen. The overall treatment performance was further evaluated using the Water Quality Index (WQI) and compared with the Malaysian Industrial Effluent Standards (Standard B). After 28 days of treatment, the FTW system achieved removal efficiencies of 71.43% for COD, 71.01% for BOD_5, 90.00% for TAN, 64.58% for TSS, 96.83% for oil and grease and 87.95% for turbidity while maintaining a stable pH throughout the treatment period. The WQI increased from 65.46 (Class III) to 82.45 (Class II), indicating significant improvement in overall water quality. These findings demonstrate that the Vetiver-based FTW system is an effective and environmentally sustainable approach for treating paper mill wastewater.

Keywords: Floating Treatment Wetland, Vetiver grass, Paper mill wastewater, Phytoremediation, Water Quality Index

AICCE 26-0070

STUDY OF CANNA LILY (CANNA INDICA) IN FLOATING WETLAND SYSTEMS FOR INDUSTRIAL WASTEWATER TREATMENT

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Abstract

Industrial wastewater from pulp and paper operations can retain dissolved organic matter, suspended particles and residual oils that require an effective polishing step before discharge. This study evaluated a laboratory-scale floating treatment wetland (FTW) planted with Canna indica for the treatment of paper mill effluent collected from the Nibong Tebal Paper Mill (NTPM). The system used a 64 L polypropylene container and a buoyant polymer raft with nine planting openings, allowing the roots to remain suspended directly in the water column. A 28-day batch retention period was adopted, with water quality assessed at seven-day intervals using pH, turbidity, total suspended solids (TSS), biochemical oxygen demand (BOD5), chemical oxygen demand (COD), and oil and grease (O&G). After 28 days, COD decreased from 246.96 to 34.50 mg/L, BOD5 from 8.45 to 1.25 mg/L, TSS from 0.048 to 0.007 mg/L, turbidity from 22.90 to 3.10 NTU, and O&G from 586.75 to 72.50 mg/L. The corresponding removal efficiencies were 86.03%, 85.21%, 85.42%, 86.46%, and 87.64%, respectively. pH remained near neutral and ended at 7.50. The results demonstrate that Canna indica-based FTW can combine physical filtration, root-zone biofilm activity and biological degradation to substantially improve the measured quality of industrial wastewater, supporting its potential as a low-energy tertiary treatment option.

Keywords: Canna indica; floating treatment wetland; phytoremediation industrial wastewater; paper mill effluent; wastewater polishing

AICCE 26-0071

ACOUSTIC AND MECHANICAL PERFORMANCE OF NATURAL FIBER REINFORCED LIGHTWEIGHT CONCRETE FOR SUSTAINABLE NOISE BARRIERS

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Abstract

Excessive environmental noise pollution and massive agro-industrial waste accumulation pose major ecological and public health challenges. This study investigates the acoustic attenuation and mechanical properties of eco-friendly lightweight concrete incorporating oil palm agricultural by-products— palm kernel shells (PKS) and oil palm broom fibers (PB)—as partial coarse aggregate replacements. Concrete specimens were formulated based on Grade C30 concrete mix design under Exposure Class XC1 (50-year structural working life) and tested for slump workability, hardened density, compressive strength (at 7, 14, and 28 days), and normal incidence sound absorption performance (0–5600 Hz) using a two-microphone impedance tube across varying rear air cavity depths (10 mm, 20 mm, and 30 mm). Experimental findings demonstrated that replacing crushed granite with 20% PKS and varying proportions of PB (0.5% and 1.0%) produced medium workability slumps (61–66 mm) and effectively reduced concrete density to lightweight levels (2037– 2067 kg/m³ at 28 days). The composite mix containing 20% PKS and 0.5% PB achieved an optimal balance between structural capability and acoustic efficiency, attaining a 28-day compressive strength of 29.9 N/mm² (meeting structural requirements near Grade C30) and a peak sound absorption coefficient of 0.381. Increasing PB replacement to 1.0% significantly enhanced sound absorption to a maximum coefficient of 0.737, albeit with a reduction in 28-day compressive strength to 22.85 N/mm² (Grade C20 equivalent). These results confirm that natural fiber-reinforced agro-waste concrete composites offer a highly viable, sustainable, and high-performance alternative for precast traffic noise barriers and acoustic wall applications in sustainable civil infrastructure.

Keywords: Lightweight concrete, palm kernel shell, oil palm broom fibers, sound absorption, compressive strength.

AICCE 26-0072

COMPARATIVE STUDY OF RUBBER CRUMB SIZES AND PERCENTAGES IN ACOUSTIC CONCRETE FOR NOISE REDUCTION APPLICATION

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Abstract

This research evaluates the acoustic, physical, and mechanical properties of acoustic concrete modified with varying rubber crumb sizes (1–2 mm, 3–5 mm, >6 mm, and shredded 10–20 mm) and partial fine aggregate replacement ratios (5%, 10%, and 15% by weight). Experimental investigations included Sound Absorption Coefficient (SAC) analysis using impedance tube testing (0–5600 Hz), hardened bulk density, compressive strength testing at 28 days, and microstructural characterization via Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDX). The control mix achieved a density of 2095.27 kg/m³ and compressive strength of 26.3 MPa. Incorporating waste tyre rubber reduced density (down to 1865.27 kg/m³ for S-15) and compressive strength due to lower aggregate specific gravity and weaker rubber-cement paste interfacial bonding. However, acoustic performance improved substantially with higher replacement levels and larger particle sizes, reaching a peak average SAC of 0.91 in the 3000–5000 Hz frequency range for 15% shredded rubber. A 10% replacement level using 3–5 mm rubber crumb (R3-10) was identified as the optimal mix design, providing an average SAC of 0.508 while preserving a structural compressive strength of 20.3 MPa. These results confirm the feasibility of rubberized concrete for sustainable precast noise barriers and acoustic panels.

Keywords: Acoustic concrete, rubber crumb, sound absorption, compressive strength, waste tyres.

AICCE 26-0073

LAND USE CHANGES IN A RURAL AREA: A CASE STUDY OF BANDAR BAHARU, KEDAH

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Abstract

Land-use change in rural areas reflects the changing spatial structure of settlements, vegetation, agriculture, and other human activities. This study assesses the spatial and temporal changes in major land-use categories within a selected rural section of Bandar Baharu, Kedah, between 2003 and 2026 using Geographic Information System (GIS)-based spatial analysis. Land-use information was compiled from existing spatial datasets, PLANMalaysia's I-Plan land-use information, and high-resolution imagery. The available information was visually interpreted and refined through manual vectorisation in QGIS to establish a consistent classification framework for the three observation periods. Six major land-use categories were identified, namely forest, plantation, bareland, built-up areas, grassland, and agriculture. The area and proportion of each category were calculated and compared for 2003, 2016, and 2026 to examine the magnitude and spatial pattern of land-use change. The results show that forest remained the dominant land-use category but decreased from 75.95% in 2003 to 57.30% in 2026, representing an overall reduction of 18.65 percentage points. In contrast, built-up areas increased from 8.97% to 21.62%, while plantation areas increased from 1.27% to 8.17%. Grassland decreased from 10.35% to 5.56%, whereas bareland increased from 2.34% to 4.80%. Agricultural land showed a smaller overall increase from 1.12% to 2.55%, despite a slight decrease after 2016. Overall, the selected rural section experienced a gradual transformation of its land-use composition, characterised mainly by the expansion of built-up and plantation areas alongside reductions in forest and grassland. The GIS-based mapping approach provides a spatial basis for understanding local rural land-use transformation and supports future land-use planning within the broader Bandar Baharu context.

Keywords: Land Use Change, Rural Area, GIS, Land Use Mapping, Bandar Baharu, Kedah

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HYDRAULIC RESPONSE AND FLOW RESISTANCE OF A SUBSURFACE DRAIN MODULE FOR URBAN FLOOD RISK

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Abstract

This study investigates the hydraulic response and flow resistance of a half subsurface drain module (SDM) for urban stormwater management. Laboratory experiments were conducted using a 5.9 m rectangular flume at a longitudinal slope of 1:750 under Gate Fully Open (GFO) conditions. Flow depth and velocity were measured at nine sections (S1–S9) along the SDM to evaluate the hydraulic characteristics and spatial variation in flow resistance. The measured data were used to determine the hydraulic radius, Froude number, and Manning's roughness coefficient. The results showed that flow velocity ranged from approximately 0.34 to 0.48 m/s, while flow depth varied between 0.123 and 0.171 m. A negative relationship was observed between flow velocity and flow depth ($R^2 = 0.744$). Manning's roughness coefficient showed a strong negative relationship with flow velocity ($R^2 = 0.958$) and a positive relationship with flow depth ($R^2 = 0.884$). The Froude number ranged from 0.76 to 1.26, indicating both subcritical and supercritical flow conditions. Spatial analysis showed that Manning's n generally decreased from approximately 0.031–0.034 at the upstream sections to 0.021–0.022 at the downstream sections. These findings provide experimental information on the hydraulic behaviour and estimated flow resistance of half subsurface drain modules under the tested conditions. The results may support further evaluation and improvement of subsurface drainage systems for urban stormwater management.

Keywords: Subsurface Drain Module; Hydraulic Performance; Stormwater Drainage; Flow Characteristics; Manning's Coefficient; Urban Flood

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AICCE 26-0075

FROM GREEN CONSTRUCTION TO SMART MAINTENANCE: AN OVERVIEW OF NATURE-BASED SOLUTIONS FOR SUSTAINABLE URBAN STORMWATER MANAGEMENT

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Abstract

Rapid urbanisation and climate change are placing increasing pressure on urban stormwater systems, leading to greater runoff, flooding and water quality deterioration. Nature-based solutions (NbS) such as constructed wetlands, bioretention systems, vegetated swales and green roofs offer sustainable alternatives to conventional drainage. However, their long-term performance depends on effective monitoring and maintenance, as sediment accumulation, clogging, vegetation changes and reduced infiltration can gradually impair their function, while conventional periodic inspections may fail to detect such deterioration. This paper reviews the transition from green construction to smart maintenance of NbS for urban stormwater management. The review outlines common NbS types and examines smart technologies such as IoT sensors, remote sensing, GIS, data analytics, artificial intelligence, and real-time control systems. Recent applications in developed countries are examined including internet-connected water level sensor networks, low-cost IoT monitoring of green roofs and real-time adaptive control of stormwater harvesting tanks. The findings indicate that these technologies can support continuous monitoring and enable more targeted and predictive maintenance. However, current evidence is largely based on modelling and pilot-scale studies. Long-term field validation together with the development of low-cost and locally adaptable monitoring solutions are needed to support smart NbS applications in tropical regions such as Malaysia.

Keywords: Nature-based Solutions (NbS), Internet of Things (IoT), Remote Sensing, Artificial Intelligence, Real-time control Systems

AICCE 26-0076

EFFECTS OF EXPOSURE TIME AND INITIAL CONCENTRATION ON MALACHITE GREEN SOLUTIONS UNDER HIGH-FREQUENCY ELECTROMAGNETIC FIELD: AN EXPLORATORY LABORATORY STUDY

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Abstract

Malachite green (MG) is a toxic and persistent cationic triphenylmethane dye that is poorly removed by conventional wastewater treatment methods. High-frequency electromagnetic fields (HF-EMF) have been proposed as a reagent-free treatment option; however, evidence on their application for dye treatment remains limited. In this exploratory laboratory study, synthetic MG solutions at concentrations of 5, 15, and 30 mg/L were prepared in tap water (39.8 L) and exposed to a fixed 6.5 MHz electromagnetic field in a batch reactor for 72 hr. Samples were collected at 24, 48, and 72 hr, together with dye-free controls with and without field exposure. pH, turbidity, colour, dissolved oxygen, conductivity, hardness, alkalinity, and absorbance at 562 nm were measured. Between the 24 hr and 72 hr samples, colour decreased by 68.8%, 63.0%, and 51.0%, while absorbance decreased by 80.0%, 66.7%, and 16.7% in the 5, 15, and 30 mg/L solutions, respectively. Turbidity decreased by 60% to 80%, while conductivity and hardness generally increased, and pH moved towards neutrality. By 72 hr, the colour and absorbance of the two lower-concentration solutions were close to those of dye-free tap water. Therefore, both exposure time and initial MG concentration were associated with the degree of optical change, with lower concentrations showing a stronger response. However, the experimental design had several limitations, including the absence of time-zero dye measurements, a field-free dye control, temperature and field-strength records, and experimental replication. In addition, the earliest absorbance values were substantially lower than expected based on the nominal MG concentrations. Therefore, the data demonstrate that the field-exposed solutions changed over time, but do not establish that the field removed or degraded the dye. A controlled experimental design is proposed to clarify whether HF-EMF directly contributes to MG removal or degradation.

Keywords: Malachite green, high-frequency electromagnetic field, dye wastewater, decolorization, physicochemical parameters

AICCE 26-0077

THERMOELECTRIC AND MECHANICAL PERFORMANCE OF ZNO NANOPARTICLE-MODIFIED CEMENT-BASED MATERIALS FOR WASTE HEAT HARVESTING

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Abstract

The development of cement-based materials with both mechanical strength and thermoelectric functionality offers a potential approach to harvesting low-grade waste heat from civil infrastructure. This study investigated the effects of zinc oxide (ZnO) nanoparticles on the mechanical and thermoelectric properties of cement-based materials. Five mixtures containing 0–1.0 wt.% ZnO were prepared, and their compressive strength, Seebeck coefficient, electrical conductivity, and thermal conductivity were systematically evaluated. Microstructural characteristics were further examined using scanning electron microscopy and energy-dispersive X-ray spectroscopy. The results showed that ZnO nanoparticles delayed early-age strength development but improved compressive strength at later ages. At 0.8 wt.% ZnO, the 28 days compressive strength reached 53.60 MPa, representing a 19.5% increase over the reference mixture. The Seebeck coefficient increased from 0.62 to a maximum of 3.44 μV/K at the same dosage. Electrical conductivity increased progressively with ZnO content, reaching 0.081 S/m at 1.0 wt.%, while thermal conductivity decreased overall to a minimum of 1.18 W/(m·K). The highest power factor of 8.05×10^{-13} W/(m·K²) and calculated thermoelectric figure of merit of 1.83×10^{-10} was obtained at 0.8 wt.% ZnO, corresponding to approximately 74.8-fold and 83.9-fold improvements, respectively. These findings demonstrate that an appropriate ZnO nanoparticle dosage can improve mechanical strength and thermoelectric response simultaneously, providing a basis for developing multifunctional cement-based materials for potential waste heat harvesting applications.

Keywords: ZnO nanoparticles; Cement-based materials; Thermoelectric properties; Seebeck coefficient; Compressive strength; ZT; Waste heat harvesting.

AICCE 26-0078

THREE DECADES OF RESEARCH ON FLY ASH-DERIVED ZEOLITES FOR AMMONIUM REMOVAL: A BIBLIOMETRIC AND THEMATIC MAPPING STUDY (1996–2025)

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Abstract

Converting coal fly ash into zeolites for ammonium (NH_4^+) removal addresses two problems at once: disposing of a bulky combustion residue and controlling nitrogen discharged to receiving waters. The experimental literature on this idea is now three decades old, yet the field's organisation and direction remain unmeasured. A total of 120 Scopus records were retrieved using the terms fly ash, zeolite and ammonium, and 83 documents published between 1996 and 2025 were retained for analysis after manual screening. Standard performance indicators were combined with a dictionary-based coding of 26 research concepts in titles, abstracts and keywords; the concept co-occurrence network was then partitioned with the Louvain algorithm, and concept shares were compared across three periods. The documents have been cited 5,613 times (mean 67.6; h-index 35) and are scattered over 60 sources, with Fuel being the most frequent (8 documents). China produced 38 documents, including 17 of the 29 published since 2017, whereas Spain, with only 12, has the most citations (1,746) owing to its early synthesis work. International co-authorship is uncommon (19.3%). Three clusters emerged, centred on synthesis route and sorption behaviour; the water matrix together with co-removal and recovery; and zeolite phase and exchange capacity. Between the first and last periods, isotherm and kinetic modelling grew from 17% to 55% of documents, regeneration from 8% to 38% and nutrient recovery from nothing to 21%, while heavy-metal co-removal shrank from 42% to 10%. By contrast, explicit reporting of cation exchange capacity dropped from 43% in 2009–2016 to 14% in 2017–2025. Only three documents addressed columns or breakthrough behaviour; the most recent pilot-scale study dates from 2015, and none attempted a life-cycle or techno-economic assessment. Overall, the field has largely settled whether these materials exchange NH_4^+; it still lacks evidence at the scale and in the format engineers need. Therefore, standardised reporting of exchange capacity, continuous-flow tests in real effluents, regeneration linked to nutrient recovery, and cost and environmental assessment are recommended priorities.

Keywords: Bibliometric analysis, Coal fly ash, Synthetic zeolite, Ammonium removal, Science mapping

AICCE 26-0079

MECHANICAL AND DURABILITY PERFORMANCE OF ALKALI-ACTIVATED GGBFS–FLY ASH CONCRETE AS A LOW-CARBON ALTERNATIVE TO OPC CONCRETE

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Abstract

In this study, an ultra-low-carbon concrete (ULC) incorporating ground granulated blast-furnace slag (GGBFS), fly ash (FA), and alkali activators (NaOH + Na2SiO3) was developed and compared with ordinary Portland cement (OPC) concrete. Three levels of FA replacement (10%, 20%, and 30%) were investigated under a fixed binder content of 400 kg/m³ and a constant water-to-binder ratio of 0.44. The mechanical performance was evaluated by compressive strength tests at 7, 14, and 28 days, while durability was assessed via porosity, water absorption, and rapid chloride penetration test (RCPT). The results demonstrated that ULC concretes exhibited comparable or superior compressive strength to OPC mixtures, with ULC-20FA achieving the highest 28-day strength (58.72 MPa), despite exhibiting lower strength than ULC-10FA at 7 and 14 days. Furthermore, ULC mixtures displayed reduced porosity and water absorption, and substantially improved chloride resistance. ULC-20FA showed the lowest chloride permeability (1237 C), consistent with a denser matrix likely resulting from synergistic C-A-S-H gel formation. These findings suggest that alkali-activated GGBFS-FA systems may serve as sustainable, high-performance alternatives to OPC concrete, aligning qualitatively with carbon-reduction goals in the construction industry based on reduced clinker content (a quantified embodied-carbon assessment was not performed in this study).

Keywords: Alkali-activated, Fly ash, GGBFS, Ultra-low-carbon concrete, Chloride penetration resistance.

AICCE 26-0086

INFLUENCE OF AGEING AND MOISTURE CONDITIONING ON THE ADHESION PERFORMANCE OF ASPHALT BINDERS MODIFIED WITH BONDING PROMOTERS: A STATISTICAL AND FAILURE MECHANISM ASSESSMENT

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Abstract

Moisture-induced debonding and oxidative ageing can compromise the integrity of asphalt–substrate interfaces. This study evaluates the effects of alkylamine-based (ALM) and polyalkylene glycol-based (PLG) bonding promoters, each incorporated at 0.5% and 1.0% by binder mass, on the adhesion of asphalt binder to granite and concrete substrates. Pneumatic Adhesion Tensile Testing Instrument (PATTI) measurements were evaluated under unaged, distilled-water, sodium-carbonate, five-day ageing, ten-day ageing and combined ageing–chemical conditioning. Pull-off tensile strength was examined together with one-way analysis of variance (ANOVA), Tukey homogeneous subsets and visual failure-mode assessment. On granite, binder formulation significantly affected adhesion following distilled-water exposure ($F = 16.692$, $p < 0.001$), whereas on concrete, significant differences were observed following sodium-carbonate exposure ($F = 7.504$, $p = 0.006$) and five-day ageing ($F = 3.988$, $p = 0.035$). The 0.5% ALM formulation yielded a granite unaged-dry mean of 432.673 psi and a concrete unaged-dry mean of 429.940 psi in the reported subset tables. The 0.5% formulations predominantly exhibited cohesive failure, while 1.0% formulations more often showed mixed failure. These findings demonstrate that the apparent benefit of bonding promoters depends on substrate and conditioning environment, and that a 0.5% dosage offers a favourable balance of adhesion strength and failure morphology within the investigated matrix. Interpretation is constrained by conditioning-specific statistical tests and the absence of independently verified field performance.

Keywords: PATTI; Pull-Off Tensile Strength; Bonding Promoter; Moisture Damage; Failure Mode

AICCE 26-0089

EVALUATING THE IMPACT OF SEQUENTIAL STORM EVENTS ON HYDRAULIC EFFICIENCY OF URBAN DETENTION POND

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Abstract

Detention ponds are widely used in stormwater management to reduce peak runoff discharge and mitigate urban flooding; however, their performance is commonly evaluated using single design storm events, which may not adequately represent actual rainfall conditions where multiple storms occur in close succession. This study evaluated the hydrologic response of a detention pond under both single and sequential storm events using the Hydrologic Engineering Center–Hydrologic Modeling System (HEC-HMS). Design storms corresponding to 2, 5, 10, 20, 50, and 100-year Average Recurrence Intervals (ARIs) were developed based on the local Intensity-Duration-Frequency (IDF) relationship. Single storm simulations were performed to establish baseline detention pond performance, while sequential storm scenarios were generated using combinations of design storms with inter-event durations of 15 minutes, 30 minutes, 1 hour, and 6 hours. The hydraulic responses were assessed in terms of peak outflow discharge and maximum water level. The results shows that higher ARI produced higher hydraulic responses as massive volume of rainfall flows through and overwhelm the natural landscape's ability to absorb water. This is common as detention ponds are designed to withstand 100-years ARI and only for a single extreme rainfall event. Sequential storm events however, generated greater hydraulic responses than single storm events, particularly under short inter-event durations. As the inter-event duration increased, the detention pond exhibited improved recovery and reduced cumulative effects, with the 1-hour and 6-hour gap scenarios producing responses approaching those of individual storm events. The responses occurred under the 15-minutes and 30-minutes gap scenario for a combination of 2+20+100 year-ARI, where peak outflow discharge reached almost the same as single 100-year ARI. However, the water level does not overflow out of detention pond even with storm sequences. The findings demonstrate that sequential storm events can increase detention pond hydraulic loading compared with conventional single storm conditions and design but it is reasonable. It is recommended to consider storm sequences in future stormwater management studies and detention pond design to achieve a more realistic assessment of system performance and resilience under extreme rainfall conditions. Further studies on the variations of sequences and its properties in real data would provide the best result in proving the detention pond efficiency.

Keywords: Storm sequence events, HEC-HMS, Peak outflow discharge, Maximum water level.

AICCE 26-0090

MONITORING COD, BOD, TOTAL NITROGEN AND TSS IN A LAB-SCALE RECIRCULATING AQUACULTURE SYSTEM FOR INDOOR MUD CRAB FARMING

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Abstract

Mud crab (Scylla spp.) farming is moving indoors, where recirculating aquaculture systems (RAS) allow water to be treated and reused under controlled conditions. The success of such a system depends on how well its water quality is monitored. This paper reviews the literature behind a lab-scale RAS treatment design for indoor mud crab farming and serves as the foundation for two linked monitoring studies. The review covers the biology and life cycle of the mud crab, its marketing chain and handling, the main components of a RAS, and previous RAS studies summarised by system scale, species, operating conditions, monitored parameters and challenges. Four water quality parameters are then compared: chemical oxygen demand (COD) and total nitrogen (TN), monitored in the first study, and biochemical oxygen demand (BOD) and total suspended solids (TSS), monitored in the second. The comparison shows that COD and BOD both describe organic load but differ in what they measure and how quickly results are obtained, that TN covers all nitrogen forms rather than ammonia alone, and that TSS represents the particulate load that feeds much of the organic and nitrogen burden. Used together, the four parameters give a complementary picture of water quality in a mud crab RAS. The gaps and challenges identified in earlier work are used to define the scope of the planned experiments.

Keywords: Recirculating aquaculture system, Mud crab, COD and BOD, Total nitrogen, Total suspended solids

AICCE 26-0091

THE APPLICATION OF BIOCHAR IN WASTEWATER TREATMENT: A REVIEW OF RESEARCH FROM PRODUCTION AND MODIFICATION TO POLLUTION CONTROL

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Abstract

Biochar, a carbon-rich porous material derived from biomass pyrolysis, has attracted increasing attention as a sustainable adsorbent for wastewater treatment. Due to its high surface area, abundant functional groups and low production cost, biochar has been widely investigated for the removal of various pollutants including heavy metals, dyes, antibiotics and nutrients. This review summarizes recent advances in biochar production, physicochemical properties and modification strategies aimed at improving pollutant removal performance. The mechanisms involved in pollutant adsorption, including ion exchange, surface complexation, pore filling and π–π interactions, are discussed in detail. Furthermore, the application of biochar in integrated wastewater treatment systems such as constructed wetlands, biofilters and advanced oxidation processes is reviewed. Environmental sustainability issues, including life cycle assessment, regeneration and potential environmental risks, are also addressed. Finally, current challenges and future research directions for the large-scale application of biochar in wastewater treatment are highlighted. This review provides a comprehensive overview of biochar-based technologies and offers insights for the development of sustainable wastewater treatment strategies.

Keywords: Biochar, Wastewater treatment, Adsorption mechanisms, Structure–function relationship, Hybrid treatment systems

AICCE 26-0093

PRIORITISATION OF BUILDING INFORMATION MODELING (BIM) AND AGILE PRINCIPLES IN MALAYSIA'S CONSTRUCTION INDUSTRY: A FIVE-PHASE LIFE-CYCLE

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Abstract

The Malaysian construction industry faces persistent challenges regarding project delays, cost overruns, and stakeholder fragmentation. While Building Information Modeling (BIM) provides an advanced digital data repository, traditional project management frameworks often fail to accommodate its dynamic, iterative nature. This study evaluates and prioritizes the integration of BIM functions and Agile principles across a five-phase project life cycle in Malaysia. Using a non-probability purposive sampling approach, survey data were collected from 48 construction practitioners, including architects, contractors, quantity surveyors, consultants, and BIM experts, in Kuala Lumpur and Pulau Pinang. Relative Importance Index (RII) analysis revealed the Design Phase as the primary locus of integration, driven by 3D visualization, model clarity, and automated clash detection. The Construction and Operational Phases tied for second priority, emphasizing real-time site work tracking and accurate as-built data for proactive facility management. Furthermore, Spearman's rank-order correlation confirmed that pre-construction 3D visualization significantly enhances field work tracking, while early clash resolution drives long-term asset tracking. These findings offer strategic guidance for practitioners and policymakers seeking to advance digital construction maturity.

Keywords: Building Information Modeling (BIM), Agile Principles, Project Life-Cycle Assessment

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UNRAVELLING BUILDING INFORMATION MODELING (BIM) IMPLEMENTATION BARRIERS IN CHINA'S CONSTRUCTION INDUSTRY: A HIERARCHICAL PRIORITISATION APPROACH

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Abstract

Building Information Modeling (BIM) is vital for modernizing global architecture, engineering, and construction workflows, yet its adoption in China faces severe operational and institutional barriers. Adopting a quantitative research design, this study surveyed 113 qualified AEC practitioners, including cost engineers, project managers, and BIM specialists, using purposive sampling with enterprise-ownership stratification. The data were analyzed using a hierarchical prioritization approach, one-sample t-tests for barrier criticality, and Mann–Whitney U tests to examine operational disruptions across enterprise types. Empirical results confirm that all 12 evaluated barriers across four conceptual domains represent critical bottlenecks. The "Two Skins" (Liangpi) operational disconnect between 3D digital models and legally binding 2D construction drawings emerged as the most severe barrier, demonstrating an extraordinarily high effect size. Furthermore, hypothesis testing revealed that State-Owned Enterprises experience significantly higher data-flow disruptions during the Budgeting-to-Control transition than Private Enterprises. These findings demonstrate that overcoming BIM adoption bottlenecks requires systemic regulatory reform, open data standards, and aligned contractual incentive mechanisms rather than sole reliance on technical skill development.

Keywords: Building Information Modeling (BIM), Barriers, Construction Industry

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EVIDENCE-BASED PERFORMANCE ASSESSMENT AND BENCH-SCALE DESIGN OF MICROALGAE FOR MUNICIPAL WASTEWATER TREATMENT

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Abstract

Microalgae offer a possible low-energy approach for reducing nitrogen, phosphorus and organic pollutants in municipal wastewater while producing recoverable biomass. This paper presents a literature-based performance assessment of Chlorella vulgaris and related Chlorella consortia, alongside a practical bench-scale reactor design suitable for subsequent experimental validation. Peer-reviewed experimental reports were examined to compare nutrient-removal outcomes under ambient aeration, carbon dioxide enrichment, wastewater pre-treatment, open-tank cultivation and mixed algal–bacterial operation. In a published seven-day photobioreactor study, enrichment with 5% CO_2 increased ammonium-nitrogen removal from 72% to 88%, phosphate-phosphorus removal from 81.93% to 92.8% and soluble chemical oxygen demand removal from 74.4% to 84.6%. A separate filtered-primary-wastewater study reported maximum ammonium and orthophosphate uptake of 94.18% and 97.69%, respectively, over a 12-day cultivation period. Results from a 50 L outdoor treatment tank showed substantial decreases in chemical oxygen demand, biochemical oxygen demand and nitrate concentration, although direct comparisons are limited by different wastewater strengths and analytical definitions. Drawing on these studies, a proposed 5 L batch cultivation scheme, control groups, monitoring parameters and quality-assurance plan are provided. The assessment indicates that microalgae can contribute to nutrient polishing, but harvested-biomass separation, operating conditions and reproducible real-wastewater tests determine practical feasibility.

Keywords: Chlorella vulgaris, municipal wastewater, nutrient removal, photobioreactor, resource recovery

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STRENGTH RETROGRESSION IN SOIL TREATED WITH HIGH QUICKLIME CONTENTS: A COMPARISON WITH HYDRATED LIME

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Abstract

Lime contents well above the usual design range are sometimes used when a soil is very wet or weak, on the assumption that more lime brings more strength. This paper tests that assumption by comparing quicklime (CaO) and hydrated lime [$Ca(OH)_2$] at 8, 10, 12 and 14% of total dry mixture mass, as part of a wider programme on calcium-based additives. Cylindrical specimens 50 mm in diameter and 100 mm high were compacted at the maximum dry density and optimum moisture content of each mixture, sealed in cling film, cured at room temperature and tested in unconfined compression after 14 and 28 days. The two limes behaved in opposite ways. Hydrated lime gained 63–81% in strength between 14 and 28 days at every content and reached a maximum of 2708 kPa at 12%. Quicklime held its strength at 8% but lost 47% and 44% over the same period at 10% and 12%, and specimens containing 14% quicklime crumbled to powder under load at both ages. After 28 days, hydrated lime was 1.9 to 6.5 times stronger than quicklime at the same content, although the two had been statistically similar at 8 and 10% after 14 days. Expressing the dosage as calcium content did not remove the difference, which points to a mechanism specific to quicklime, such as continued hydration and expansion within the compacted specimen, rather than to calcium excess alone. For this soil, quicklime contents above 8% should be avoided, and a 14-day strength test can seriously overstate the long-term performance of quicklime-treated mixtures.

Keywords: Quicklime, Hydrated lime, Lime dosage, Strength retrogression, Unconfined compressive strength

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OPTIMISING RAINWATER HARVESTING TANK CAPACITY FOR URBAN FLOOD MITIGATION: A CASE STUDY OF TAMAN BAGAN, BUTTERWORTH, PULAU PINANG

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Abstract

Urban flooding in dense residential catchments is exacerbated by extensive impervious surfaces, limited drainage capacity, and downstream river or tidal restrictions. Domestic rainwater harvesting (RWH) can provide distributed stormwater storage by temporarily retaining rooftop runoff before its discharge into the drainage system. However, its flood-mitigation performance depends on storage capacity, rainfall characteristics, antecedent storage conditions, catchment characteristics, and storm severity. This study evaluates the effectiveness of household-scale RWH as a supplementary flood-mitigation measure in Taman Bagan, Butterworth, Pulau Pinang, Malaysia. An approximately 40 ha residential catchment comprising about 800 housing units was represented using an integrated 1D/2D InfoWorks ICM model. Twelve-hour design storms corresponding to 2-, 5-, 10-, 20-, 50- and 100-year average recurrence intervals (ARIs) were simulated under both freeflow and time-varying tailwater conditions. One rooftop-connected RWH tank was assigned to each household, with storage capacities of 1, 2, 3, 4 and 5 m³ evaluated based on peak discharge, runoff volume and flood extent. Results show that increasing tank capacity consistently improves hydraulic performance, although the relative reduction decreases with increasing storm magnitude. Under freeflow conditions, the 5 m³ tank achieved peak-discharge reductions of 40.57% and 12.83% for the 2- and 100-year ARIs, respectively, while reductions under tailwater conditions were 38.05% and 12.03%. However, incremental benefits became less pronounced beyond 3 m³. The 3 m³ tank achieved average reductions of 17.18% in peak discharge and 4.64% in runoff volume, while providing the clearest reduction in localised inundation during the 2-year tailwater event. Thus, 3 m³ was identified as the practical hydraulic optimum, offering meaningful attenuation with moderate storage requirements. The findings demonstrate that distributed RWH is particularly effective for frequent storm events and should complement, rather than replace, conventional drainage and other flood-mitigation measures.

Keywords: Rainwater harvesting; urban flood mitigation; tank capacity; stormwater management; InfoWorks ICM; tailwater; Taman Bagan.

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THERMAL VOC INDUCTION: A COMPARATIVE ANALYSIS OF ACTIVE CHARGING ZONES VS. TECH-FREE ZONES IN A ROOM

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Abstract

Indoor Air Quality (IAQ) is very important for our health, especially in this current era where we spend more time indoors. However, the current code of practice on IAQ mostly focuses on factors arising from building materials. This study examines how localized heat generated by charging multiple mobile devices affects Volatile Organic Compound (VOC) concentration in a residential bedroom. Environmental monitoring was conducted at 5-minute intervals across free-tech and active charging conditions, timelines, and two ventilation setups, which were mechanical-only and hybrid ventilation. Statistical analyses using SPSS showed that active charging hubs create a “thermal pump” effect. Under a nighttime mechanical-only setup, stagnant air led to a buildup of VOC concentration, resulting in statistically significant localized peaks ($t = -4.5$, $p < 0.001$). In contrast, a hybrid ventilation strategy effectively reduces the release of VOC, achieving an average pollutant reduction of 92.63 ppm ($t = 78.72$, $p < 0.001$) overnight. A One-Way ANOVA confirmed that ventilation layouts and operational timelines influence indoor VOC concentration. Pearson correlation analysis show that these environmental variables are closely linked, but their relationships depend heavily on the room's baseline conditions. Additionally, four Multiple Linear Regression (MLR) models predicted breathing-zone VOC variations based on temperature, humidity, and power load ($R^2 > 0.920$). The Nighttime Mechanical-Only model was exceptionally strong ($R^2 = 0.983$, $F = 625.616$, $p < 0.001$). Overall, the predictive model and empirical findings of this research contribute to the fields of civil engineering and sustainable indoor space management by providing practical data to formulate targeted local ventilation strategies and the suitable location of the plug. This protects people from breathing in elevated localized contaminants over extended exposure durations and addresses the impact of localised anthropogenic emissions.

Keywords: Indoor Air Quality (IAQ); Volatile Organic Compound (VOC); Thermal VOC induction; Localized heat dissipation; Electronics devices; Multiple Linear Regression (MLR)

AICCE 26-0106

INFILTRATION BEHAVIOUR OF GREEN ROOF MEDIA CONTAINING RECYCLED CRUSHED CONSTRUCTION MATERIAL UNDER SIMULATED TROPICAL RAINFALL

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Abstract

Conventional green roof substrates rely on virgin or energy-intensive aggregates, while construction and demolition waste is largely landfilled. This study assessed recycled crushed construction material (RCCM), in the form of crushed concrete, as a partial replacement for gravel in extensive green roof substrates under tropical conditions. Three vegetated Perspex columns (20 cm × 20 cm × 45 cm) were tested: Column 1 (C1) with 50% sand and 50% gravel; Column 2 (C2) with 50% sand, 25% gravel and 25% crushed concrete, thoroughly mixed; and Column 3 (C3) with the C2 proportions placed in discrete layers. Sieve analysis and constant head permeability tests were used to characterise the materials, and all three mixtures gave saturated hydraulic conductivities of 0.284–0.475 cm/s. Each column was then subjected to four 30-minute simulated rainfall events at a design intensity of 72 mm/h, the maximum one-hour intensity recorded at the Kolam Takungan Bukit Panchor station. Minute-by-minute drainage was used to derive apparent infiltration capacity, which was fitted with Horton's equation, while drainage turbidity and substrate load were also measured. Drainage began after 5–10 min in all columns. Mean water retained over 30 min was 581 mL for C1, 561 mL for C3 and 474 mL for C2, and C3 showed the most consistent response between events. C2 produced the clearest drainage (9.58 NTU), whereas C3 produced the most turbid (24.81 NTU). C3 imposed the lowest dry substrate load (0.096 kN, about 2.4 kPa). The results indicate that RCCM can replace part of the natural gravel in extensive green roof substrates without loss of hydraulic suitability, with the placement method governing the trade-off between response consistency and drainage water quality.

Keywords: green roof, recycled concrete aggregate, infiltration, Horton model, turbidity

AICCE 26-0108

THERMAL PERFORMANCE OF ORGANIC AND INORGANIC SUBSTRATES FOR EXTENSIVE GREEN ROOFS UNDER TROPICAL CONDITIONS: AN IOT-MONITORED FIELD STUDY

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Abstract

The growing medium is a key design variable for the thermal performance of extensive green roofs, yet field evidence comparing organic and inorganic substrates under equatorial conditions remains limited. This study compared a 1:1 mixture of organic soil and coco peat with a 100% sand substrate for extensive green roofs in Penang, Malaysia. Three 1.0 m × 0.5 m modules with concrete bases and a 2% slope were built: Module A (bare concrete control), Module B (10 cm organic soil and coco peat) and Module C (10 cm sand), with Modules B and C vegetated with Zoysia japonica sod. The substrates were characterised by sieve analysis, constant head permeability and bulk density tests. An ESP32-based Internet of Things (IoT) system logged substrate moisture and concrete-underside temperature at 15-minute intervals over 53 days (9 April–31 May 2026). The organic mixture contained 17.65% fines, had a permeability of 0.073 cm/s and a compacted bulk density of 0.99 g/cm³. The sand contained 0.55% fines, had a permeability of 0.122 cm/s and a bulk density of 1.68 g/cm³. Moisture records showed that the organic substrate stayed wet for several days after rain, whereas the sand drained within hours. On the hottest dry-spell day analysed (22 May 2026), the peak underside temperature was 35.44 °C under Module B, 35.94 °C under the bare control and 40.81 °C under Module C, which also peaked about one hour earlier. The 0.50 °C benefit of the organic module is close to the sensor's nominal accuracy, while the sand module's 4.87 °C penalty warrants further verification. The results indicate that standalone sand is unsuitable as an extensive green roof substrate in the humid tropics on structural and thermal grounds, and that moisture-retentive organic media should be preferred.

Keywords: green roof, substrate, coco peat, thermal performance, Internet of Things

AICCE 26-0115

UTILIZING BLACK SOLDIER FLY LARVAE (BSFL) IN BOKASHI COMPOSTING TO ENHANCE LIGNOCELLULOSIC DEGRADATION OF EMPTY FRUIT BUNCH (EFB)

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Abstract

Empty fruit bunches (EFB) generated by the palm oil industry require sustainable treatment to reduce disposal impacts and recover useful organic material. This study evaluated the incorporation of black soldier fly larvae (BSFL) into laboratory-scale Bokashi composting to improve EFB degradation and compost maturity. Control and BSFL-treated compost were monitored over 49 days. The assessment covered temperature, moisture content, pH, electrical conductivity, carbon-to-nitrogen (C/N) ratio, lignocellulosic composition, and germination index. Fibre fractions were determined using the Van Soest method, and differences in hemicellulose, cellulose, and lignin content were assessed using one-way analysis of variance. The BSFL-treated compost reached a maximum temperature of 38.3 °C. Its final C/N ratio was 31.4, compared with 41.5 in the control, although neither treatment reached the stated optimum. Germination indices were 141.7% for BSFL-treated compost and 65% for the control. Hemicellulose content decreased in both treatments, while cellulose and lignin varied during composting. Between-treatment differences in the three fibre fractions were not statistically significant ($p > 0.05$). The results suggest that BSFL incorporation can support compost maturation and improve germination performance, while further optimisation of larvae concentration, moisture control, and composting duration is needed to establish its effect on lignocellulosic degradation.

Keywords: BSFL, Bokashi, EFB, lignocellulose, composting

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OPTIMIZING LIGNOCELLULOSIC DEGRADATION IN BOKASHI COMPOSTING WITH BLACK SOLDIER FLY LARVAE FRASS

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Abstract

Empty fruit bunches (EFB) from the palm oil industry contain lignocellulosic components that resist conventional composting. This study investigated black soldier fly larvae (BSFL) frass as an additive to improve lignocellulosic degradation and compost quality in Bokashi composting. Two treatments were monitored for 49 days: EFB mixed with BSFL frass, Bokashi starter, and palm oil mill effluent, and a control mixture without frass. Composting was conducted in 9 L lidded bins under semi-aerobic conditions. Temperature, pH, electrical conductivity, moisture content, carbon-to-nitrogen (C/N) ratio, lignocellulosic composition, and germination index were assessed. The frass treatment reached a final pH of 8.39 and moisture content of 56%, while temperatures remained within the mesophilic range. Its C/N ratio decreased from 60.2 to 37.0, compared with a final value of 41.6 in the control; neither treatment reached the stated maturity threshold of less than 25. Lignin degradation was 62.4% with frass and 43.3% in the control. Germination indices were 130.8% and 120.8%, respectively. Although analysis of variance showed no statistically significant differences for most parameters, the observed improvements suggest that BSFL frass has potential as an additive for EFB Bokashi composting.

Keywords: Bokashi, BSFL, frass, lignocellulose, composting

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HYBRID ELECTROCOAGULATION-ADVANCED OXIDATION PROCESSES FOR WASTEWATER TREATMENT: A CRITICAL REVIEW OF OZONE, FENTON AND PHOTOCATALYSIS COUPLED SYSTEMS

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Abstract

Electrocoagulation (EC) removes suspended, colloidal and many dissolved pollutants through in situ generation of metal hydroxide coagulants, but it achieves limited mineralisation of soluble, recalcitrant organic compounds. Advanced oxidation processes (AOPs) degrade such compounds through hydroxyl radicals (HO•), but they are constrained by reagent and energy costs. This review critically examines studies published between 2010 and 2026 on three EC–AOP couplings: ozone–electrocoagulation (O_3/EC), electro-Fenton/electrocoagulation (EF/EC) and EC–photocatalysis. Performance data were compiled, the apparent and kinetic gains from coupling were derived where single-process data were reported, and the comparability of the reported metrics was appraised. O_3/EC achieved 30–97.5% chemical oxygen demand (COD) removal and up to 100% colour removal, and recent catalytic and dual-anode variants removed 73–95% of COD from real textile effluent and landfill leachate. Recent mechanistic work shows that synergy between ozone and hydrolysed coagulants and the electro-peroxone reaction together supply most of the HO• in O_3/EC, and the first kinetic synergy index that can be derived ($S \approx 2.4$) confirms a more-than-additive effect. EF/EC achieved 57.7–95.85% COD removal and 8–23.5 percentage points more COD removal than EC alone; since 2021, sequential EC and electro-Fenton with electrogenerated H_2O_2 reached 64–91% total organic carbon (TOC) removal in real effluents, including at near-neutral pH when EC-derived iron catalysed a solar photo-electro-Fenton step. Sequential EC–photocatalysis achieved up to 74.43% TOC removal, and the first simultaneous photo-EC system was reported in 2024. The evidence supports a complementarity model in which EC separates, ozone transforms and EF mineralises, but the best sequence is matrix-specific: ozonation after EC increased effluent toxicity in one study, whereas catalytic ozonation before EC almost eliminated it in another. Ozone sparging and dual anodes mitigated electrode passivation, and one life-cycle assessment found lower environmental burdens for O_3/EC than for EC alone. Most evidence still comes from laboratory batch tests with non-normalised energy and cost metrics. Priorities include standardised reporting (charge loading, specific energy and kinetic synergy indices), same-matrix comparisons of the couplings, pilot-scale tests on real wastewater and routine assessment of by-products, toxicity and sludge.

Keywords: Electrocoagulation, Advanced oxidation processes, Ozone–electrocoagulation, Electro-Fenton, Hybrid wastewater treatment

AICCE 26-0130

MAPPING SUBSURFACE CHARACTERISTICS OF PENANG ISLAND USING A BOREHOLE DATABASE

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Abstract

Historical site-investigation records can provide a basis for regional subsurface mapping when their spatial distribution and limitations are made explicit. This study compiled 220 boreholes from 34 site-investigation reports to map subsurface material classes and Standard Penetration Test (SPT) N values on Penang Island. Borehole attributes were organized at six depth levels, from 5 to 30 m at 5 m intervals, and linked to geographic coordinates in ArcGIS. Kriging and Natural Neighbor interpolation were used to generate depth-specific maps, while ArcScene was used to display the interpreted layers in three dimensions. The reported distribution summary shows that the sand group accounts for 44% and 40% at depths of 5 and 10 m, respectively. The combined gravel-and-granite group increases from 19% at 5 m to 55% at 30 m, indicating a greater representation of coarse material and rock in the deeper interpreted layers. The SPT maps also show a greater prevalence of higher blow-count classes at depth. Boreholes are concentrated in the eastern part of the island, and the maps therefore provide stronger local support in that region than in sparsely sampled areas. Differences between interpolation methods reflect their treatment of spatial continuity and sample coverage. The resulting maps provide a framework for preliminary ground-condition appraisal and planning further investigation; they do not replace project-specific site investigation or establish independently validated subsurface boundaries.

Keywords: GIS, Boreholes, Mapping, SPT, Penang



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