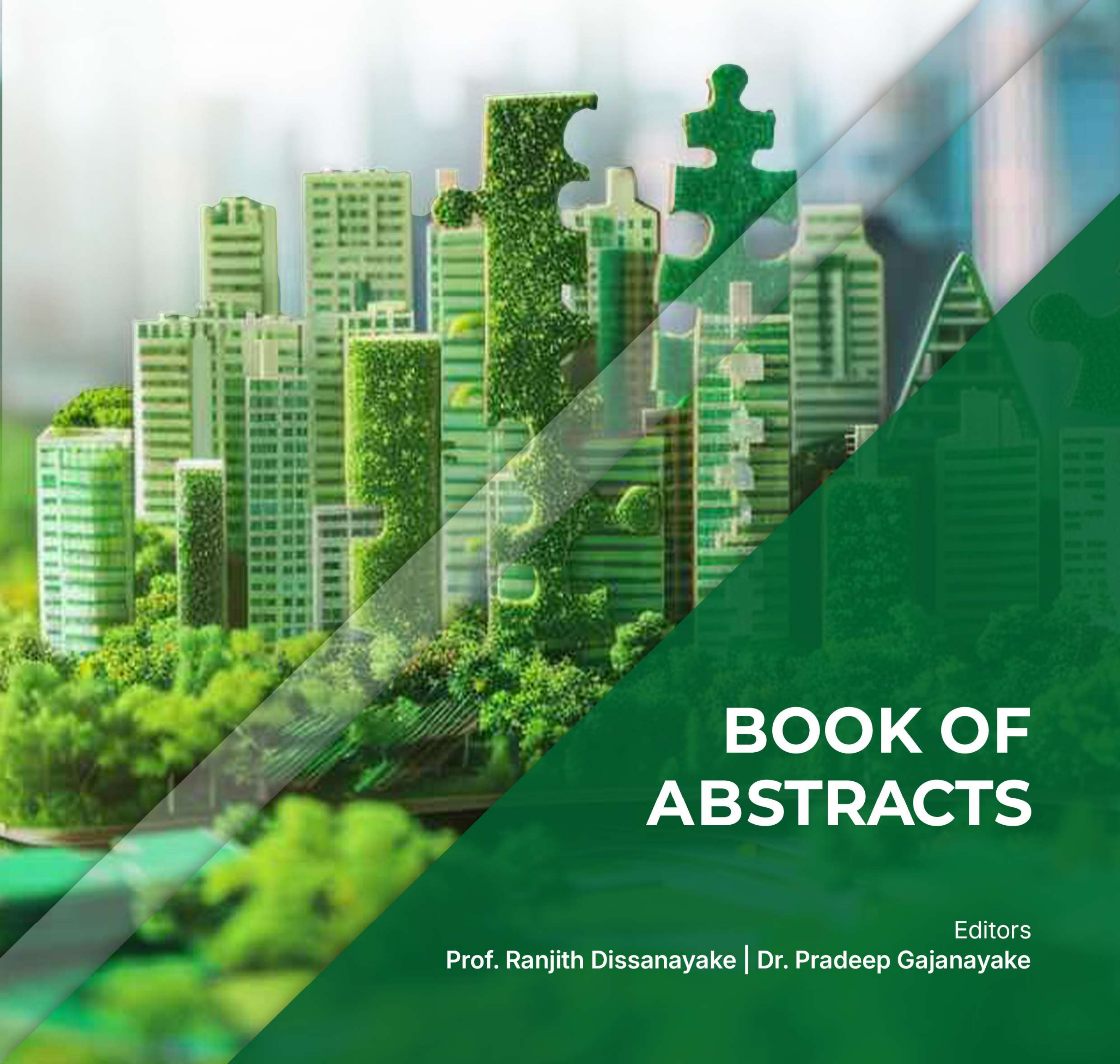
ICSBE 2025

The Kandy Conference

The 16th International Conference on

Sustainable Built Environment 2025 and Next-Gen Innovation & Advancement (DIAMOND 75)



BOOK OF ABSTRACTS

Editors

Prof. Ranjith Dissanayake | Dr. Pradeep Gajanayake

ABSTRACT BOOK OF THE 16TH INTERNATIONAL CONFERENCE ON SUSTAINABLE BUILT ENVIRONMENT (ICSBE) 2025

VISION

To drive innovative research for tomorrow's development

MISSION

To meet colleagues, experts and friends in the field and to exchange ideas and those about research development work, concepts and practical ideas in structural, construction and management

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PREFACE

It is with great pleasure that we present the abstract book of the 16th International Conference on Sustainable Built Environment (ICSBE) 2025. This is the fifteenth consecutively organized conference following a series of international conferences since 2010, keeping its tradition of adhering to engineering excellence. Taking a step forward from the last fourteen events, the coverage of specialty areas in this conference has been diversified. This book contains the manuscripts of research work from many different sub specialties. We expect that all these manuscripts will be presented at parallel sessions from 12th to 14th December 2025. We would like to express our appreciation to all keynote speakers for their invaluable contribution for the development of a sustainable world. We are also very grateful to the authors for contributing research papers of high quality. The manuscripts in this abstract book have been reviewed by a panel of academic and professional experts who have vast expertise in their respective fields. The enormous work carried out by these reviewers is gratefully appreciated as well. We are also pleased to acknowledge the advice and assistance provided by the members of the international advisory committee and members of the editorial committee along with many others who volunteered to assist to make this very significant event a success. Furthermore, we acknowledge the financial sponsorship provided by many organizations that has been extremely supportive towards the success of this international conference. It is the earnest wish of the editors that this proceeding book would be used by the research community and practicing engineers who are directly or indirectly involved in studies related to sustainable built environments.

Editors
Prof. Ranjith Dissanayake
Dr. Pradeep Gajanayake

The 16th International Conference on Sustainable Built Environment (ICSBE) 2025
12th to 14th December 2025, Kandy, Sri Lanka

MESSAGE FROM THE CONFERENCE CO-CHAIRS

It is a pleasure for us to welcome all the participants to the 16th International Conference on Sustainable Built Environment (ICSBE) 2025 in Kandy, Sri Lanka. We, the co-chairs would gratefully like to mention the previous successful conference, which was held for fourteen consecutive years in Kandy, Sri Lanka. The theme selected for the conference Sustainable Built Environment- is extremely relevant to today's world. With the vision of promoting innovative and sustainable research for tomorrow's development. We organize this conference as a meeting place of talents, knowledge, and dedication. Therefore, we trust that the conference will produce great ideas from a variety of research and exchange the knowledge of experts, colleagues, and friends who are working for the world's sustainable development. The conference focuses on the different sub-topics in the sustainable built environment: such as sustainable construction, sustainable infrastructure development & planning, urban green infrastructure & planning, sustainable cities and villages, waste & wastewater management for enhanced sustainability, advanced water & wastewater technology, rainwater harvesting, water conservation, solar energy, bio energy, wind, and hydro-power energy, alternative clean energy, green advanced computations & communication, green energy economics, policy, financing & business practice, sustainable materials, material flows & industrial ecology, high-performance concrete, remove, recycle, repair of materials, building automation, indoor environmental quality, indoor plants, impacts of climate change, climate change & reducing greenhouse emissions, carbon footprint, impacts of sustainable bio-fuel, social impact & human behavior, climate risk management & mitigation, global climate model and landscaping. The best-selected papers will be published in Springer Nature as lecture notes in civil engineering. Other full papers (which are presented at the conference) are published as conference proceedings. The host city of the conference, Kandy, is a world heritage city famous for its unique architecture, culture, nature, beauty, and climate. We hope that you will enjoy your time in Kandy during the conference. We, the conference co-chairs express our sincere thanks to our guests, keynote speakers, authors, members of the international advisory committee, members of the editorial committee financial sponsors, and many others who volunteered to assist to make this very significant event a success.

Prof. Ranjith Dissanayka
Prof. Priyan Mendis
Eng. Shiromal Fernando
Prof. Chintha Jayasinghe
Prof. Asanga Ratnaweera
Prof. Sudhira De Silva
Prof. Upul Attanayake
Prof. Ayantha Gomes
Prof. Ajith Dolage
Prof. C.S. Bandara
Dr. Ajith Thamboo
Dr. Balasubramaniam Janarthanan
Dr. K.H.P Madusanka
Dr. Thushara Madanayake

The 16th International Conference on Sustainable Built Environment (ICSBE) 2025

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ICSBE25_117

APPLICATION OF LEAN TECHNIQUES FOR MATERIAL WASTE MINIMISATION IN SRI LANKAN HIGH-RISE BUILDING PROJECTS

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Abstract: The construction industry is a key contributor to economic development in Sri Lanka, particularly through the rapid growth of high-rise buildings driven by urbanization and land scarcity. However, this growth has led to a significant increase in construction material waste generation, leading to various problematic situations and challenges. While lean construction is globally recognized for enhancing construction efficiency and minimizing waste, its application for high-rise building contexts in Sri Lanka remains underexplored. To fill this gap, this study investigates key sources of material waste in high-rise construction projects in Sri Lanka and how lean construction techniques can be strategically aligned to minimize such waste. A qualitative research approach was adopted, involving expert interviews with ten professionals engaged in the Sri Lankan construction industry to gather data. The collected data was analyzed using the thematic analysis method to identify the types and sources of material waste and map them with applicable lean techniques. Findings indicate that material waste in high-rise constructions stems from a combination of technical, managerial, and contextual issues, including design changes, inaccurate estimations, improper material handling, and supervision gaps. Techniques such as 5S, Building Information Modelling (BIM), Just-In-Time (JIT), Value Stream Mapping (VSM), and the Last Planner System (LPS) were identified as suitable lean approaches to minimize such waste. However, the effectiveness of these techniques varies based on project complexity, scale, and local implementation constraints. The contextual lean application framework developed from these findings provides strategic guidance for construction professionals to better understand more targeted and applicable lean techniques to minimize material waste. Further, the findings contribute to a deeper understanding of how lean techniques can be operationalized in high-rise projects in developing countries like Sri Lanka.

Keywords: Construction Industry; High-rise Building Construction; Lean Techniques; Material Waste Management; Waste Management

ICSBE25_303

DEVELOPMENT OF HEATLESS BIO-BASED ENGINEERING WOOD PANELS FROM RECYCLED TIMBER

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Abstract: The growing demand for sustainable and low-carbon construction materials has intensified interest in engineered wood products made from recycled timber and the use of bio-based adhesives. Traditionally, these panels are manufactured using hot-pressing, a highly energy-intensive process. Advances in bio-based adhesives capable of curing at ambient conditions now present an opportunity to produce engineered wood panels through a more energy-efficient, heatless method. This study evaluates the feasibility of manufacturing recycled wood particleboards bonded with a bio-based adhesive under cold-pressing conditions. Four panel types with sawdust percentages varying from 0-30% were produced using a cold-press fabrication process and bonded with a cashew nutshell bio-binder—AmproTM Bio. This was done to evaluate the feasibility of heatless panel production, while also examining the influence of varying fine contents on particleboard performance. The panels were tested for mechanical properties: Modulus of Rupture (MOR) and Modulus of Elasticity (MOE), and for physical properties: density, moisture content, Thickness Swelling (TS), and Water Absorption (WA), in accordance with AS/NZS 1859:2017 standards. Despite the absence of heat curing, all cold-pressed panels met or exceeded the relevant standard requirements for bending stiffness (MOE) and dimensional stability. A fines content of 10% enhanced both MOR and MOE compared with panels without fines, whereas higher fines levels (20–30%) reduced bending performance. TS and WA remained within acceptable limits across all compositions. The results confirm the existence of an optimal fines content that balances strength retention with efficient utilisation of recycled wood resources. They also demonstrate a viable pathway for industrial adoption of heatless, bio-based engineered wood panels from recycled timber—offering energy savings, reduced emissions, and alignment with circular economy principles.

Keywords: Bio-adhesives; Cold-press; Particleboard; Sustainable Composites; Wood Waste

ICSBE25_306

IMPACT OF BRACING SYSTEMS ON THE LATERAL STABILITY OF HIGH-RISE BUILDINGS

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Abstract: The rapid rise in high-rise building construction has introduced significant engineering challenges, demanding innovative strategies to address increasing structural complexities. Lateral forces, such as those induced by wind and seismic activity, can critically influence the overall stability of these structures. To counteract these effects, tall buildings typically incorporate various lateral load-resisting systems, including interconnected shear walls, outriggers, belt trusses, and steel bracing. However, selecting the most effective and economical bracing system remains a complex task, particularly in regions recently affected by severe earthquakes. This study investigates several lateral bracing mechanisms commonly adopted worldwide to enhance the stability of tall buildings, focusing on outriggers, outrigger–belt truss combinations, steel bracing, and shear walls. Comparative analyses were performed to assess their effectiveness in reducing lateral displacement and inter-storey drift. The results indicate that, compared with other lateral load-resisting mechanisms, steel bracing achieves the lowest storey drift and lateral displacement. Among the different configurations, inverted-V, X-, and V-type steel bracing systems significantly enhance lateral stability, reducing structural deflection by 27.7%, 27.1%, and 26.0%, respectively. Furthermore, these steel bracing systems also demonstrate greater cost efficiency compared with other lateral load-resisting mechanisms. Overall, the findings provide practical guidance for selecting bracing systems that ensure occupant comfort while effectively controlling inter-storey drift and overall structural deformation.

Keywords: Cost-effective; Deflection; Earthquake; High-rise Building; Lateral Load Resistance Mechanisms; Storey Drift

ICSBE25_485

IMPACT OF WIND VELOCITY ON MITIGATING HEAT COLUMN GENERATION DUE TO THE ARRANGEMENT OF CONDENSER UNIT IN HIGH-RISE BUILDINGS

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Abstract: In recent high-rise residential building constructions, air-cooled split-type air conditioners have gained popularity over central air conditioning systems due to their cost-effectiveness, installation flexibility, operational and maintenance advantages. In tropical regions, the growing reliance on air conditioning is increasing energy consumption. High-rise buildings often use split-type air conditioners for their flexibility, but installing their condensers in confined building re-entrants creates a problem. The outdoor condensing units eject heat into these narrow spaces, forming a "heat column generation" that rises in the building. This plume of hot air raises ambient temperatures on higher floors, reducing cooling efficiency, increasing energy use and risking equipment failure. This study investigates this heat column effect and explores how wind profiles can help mitigate it. Computational Fluid Dynamics (CFD) is used to simulate the heat column generation effect in a high-rise building in Colombo, Sri Lanka. The study evaluated how different re-entrant designs and condenser arrangements affect the heat column's strength. The result shows that the wind velocity profiles are a major factor, directly controlling airflow and heat dissipation. The wind conditions are most essential critical, as the wind can either intensify or alleviate the heat buildup, making an understanding of local wind patterns essential for optimizing condenser performance and mitigating the heat column formation effect. The design and placement of condenser units must account for wind velocity profiles to effectively reduce the heat column. This integration is key to improved air-conditioning system efficiency, lower energy consumption and enhanced comfort for building occupants.

Keywords: Building Energy; CFD; Heat Column Effect; High-rise Building; Split Type A/C; Wind Velocity

CLIMATE RISK MANAGEMENT AND GREENHOUSE GAS MITIGATION FOR A RESILIENT, LOW-CARBON FUTURE

ICSBE25_045

MAPPING CLIMATE RISKS AND INFRASTRUCTURE VULNERABILITIES: A DECISION-SUPPORT FRAMEWORK FOR PORTABLE WATER ASSET MANAGEMENT IN SRI LANKA

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Abstract: Climate change presents growing threats to the performance and reliability of water supply infrastructure in Sri Lanka, posing significant challenges for long-term asset management. This study develops a cognitive map that systematically captures expert insights on climate-induced stressors such as extreme rainfall, drought, sea-level rise, and temperature variability and their causal links to infrastructure vulnerabilities, including pipe failures, water quality deterioration, and service disruptions. This cognitive map forms the basis for a preliminary Failure Mode and Effects Analysis (FMEA) to support informed asset management and resilience planning. Aligned with ISO 55000 principles, the framework emphasizes lifecycle performance, risk-based decision-making, and value optimization. The proposed cognitive map and FMEA provide a scalable foundation for national water infrastructure strategies by translating complex climate risks into actionable insights, enabling authorities to proactively plan, prioritize, and implement adaptive interventions in an increasingly uncertain climate future.

Keywords: Climate Change; Failure Mode and Effect Analysis; Risk Assessment; Water Supply Infrastructure

ICSBE25_102

DEVELOPMENT OF RAINFALL INTENSITY DURATION FREQUENCY (IDF) EQUATIONS IN SRI LANKA

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Abstract: Rainfall Intensity Duration Frequency (IDF) studies are very important to engineers, who are engaged in the design of hydraulic structures and hydrologic design projects in urban drainage design, and for researchers who deal with groundwater studies in geological techniques. The main objective of this paper is to show the development of IDF relationships using short-term rainfall data and daily rainfall data for the selected 15 locations in various parts of the country. Therefore selected 15 rainfall stations to get the data to examine the variation under the climate change phenomena in Sri Lanka. This paper makes an attempt to update the IDF analysis study done by Mr. D.G.L. Ranthunga in 2001. The methodology adopted the Gumbel method for frequency analysis and used the linear log regression method for the derivation of IDF equations. This study depends on the most recent rainfall data for all locations obtained from the Department of Meteorology for the last 30 years, from 1994 - 2023, except Colombo. The Colombo rainfall study covered 33 years from 1991 to 2023 because the highest daily rainfall occurred in 1992, from the commencement of the rainfall station in 1869. The procedures to be adopted in screening, completion, and validation of rainfall, and carrying out analysis of rainfall data, were adhered to initially, and subsequently, IDF equations were derived individually for each station. The IDF curves have been developed for various return periods, such as 2 years, 5 years, 10 years, 25 years, 50 years, 100 years, and 200 years for a 24-hour duration.

Keywords: Frequency Analysis; Log-linear Regression; Rainfall Intensity; Rainfall Intensity-Duration-Frequency (IDF); Short-Duration Rainfall

ICSBE25_132

SATELLITE-BASED REMOTE SENSING ANALYSIS OF THE SPATIO-TEMPORAL DISTRIBUTION OF NO_2 IN SRI LANKA

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Abstract: Air pollution, particularly nitrogen dioxide (NO_2) from automobile exhaust, industrial activity, and biomass burning, is a critical global issue, with the World Health Organization estimating that air pollution is responsible for approximately 7 million premature deaths annually. In Sri Lanka, the health risks from NO_2 are rising due to increasing pollution levels, leading to respiratory and cardiovascular illnesses. This study evaluates the spatio-temporal trends of NO_2 in Sri Lanka from 2020 to 2025 using cloud-based satellite remote sensing techniques. Satellite data acquired from Sentinel-5P TROPOMI (Tropospheric Monitoring Instrument) were processed using Google Earth Engine, a cloud-based geospatial processing system, to analyze time series data and trends. Spatial distribution maps were generated using ArcMap to identify NO_2 concentration hotspots across the country. Results showed that the highest monthly NO_2 concentrations were recorded during the 2021 – 2022 period (particularly in April 2021). The annual NO_2 concentration peak was recorded in 2022, correlating with the post-pandemic season and resumption of transportation and economic activities. Over the study period, the analysis revealed that the Colombo district had the highest annual mean concentrations, followed by Gampaha and Kegalle, urban and peri-urban areas with heavy traffic and industrial activity. In contrast, rural areas such as Monaragala and Manner exhibited the lowest concentrations. These findings show higher NO_2 concentration levels in urban areas and emphasize the urgent need for enhanced air quality monitoring systems and sustainable urban development by adopting techniques for early pollution detection and mitigating public health risks in high-risk districts such as Colombo and Gampaha. Policymakers should prioritize emission control strategies, such as expanding public transport, re-establishing vehicle emission standards, while promoting renewable energy usage. Additionally, conducting health impact assessments in high-risk districts is recommended to better understand and mitigate the public health effects of elevated NO_2 levels.

Keywords: Air Pollution; Air Quality; Google Earth Engine (GEE); Health Risk; Sentinel-5P; Urban Emissions

ICSBE25_243

COMPARATIVE ANALYSIS OF MACHINE LEARNING MODELS FOR WEATHER FORECASTING AND DECISION SUPPORT IN COLOMBO WITH SARIMA AS THE OPTIMAL MODEL

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Abstract: Accurate and localized weather forecasting is increasingly essential in Sri Lanka, particularly in the face of rising climatic variability that directly affects agriculture, small businesses, public safety, and disaster preparedness. This research investigates a comparative analysis of five Machine Learning (ML) models: Long Short-Term Memory (LSTM), Auto Regression (AR), ARIMA, SARIMA, Support Vector Regression (SVR), and Random Forest, to improve short-term, high-resolution weather forecasting in the Colombo region. The models were trained using twenty years of hourly historical weather data to forecast five key meteorological parameters: temperature, humidity, rainfall, wind speed, and atmospheric pressure. The information was strictly pre-processed to improve model performance, e.g., normalization, outlier removal, missing value imputation, and advanced time-based feature engineering to improve the explanation of temporal patterns. Model performance is measured in terms of standard statistical metrics like Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Coefficient of Determination (R^2). Early experimental results show that LSTM and Random Forest models have shown promising accuracy in detecting nonlinear relationships and seasonal patterns, despite final judgments still being in progress. To enhance practical usability, a prototype of a web-based dashboard is under development. This dashboard is designed to deliver real-time, location-specific weather forecasts tailored for end-users such as farmers and small business operators in Colombo and to support real-world applications, a user-friendly web-based dashboard. Parallel to this, an IoT-based weather monitoring system has been designed using NodeMCU microcontrollers and environmental sensors to enable continuous live data acquisition. The system is set up to feed actual-time sensor data to the models for forecasting in order to facilitate dynamic updating and improve overall prediction accuracy. Although final outputs and complete system integration are ongoing, the suggested ML-IoT hybrid framework is a scalable, cost-efficient, and adaptable solution to localized forecasting and climate resilience. It is viable for replication within other regions in Sri Lanka and similar developing contexts with climate uncertainties.

Keywords: Decision Support; IoT; LSTM; Machine Learning; Weather Prediction

ICSBE25_321

A COMPREHENSIVE ASSESSMENT OF GREENHOUSE GAS EMISSIONS AND DECARBONIZATION STRATEGIES IN APPAREL INDUSTRY: A CASE STUDY IN SRI LANKA

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Abstract: The apparel industry is responsible for 7% of annual Greenhouse Gas Emissions annually and currently, many of the market-leading brands are promoting Science-Based decarbonization across the apparel supply chain in order to create a sustainable industry. This research focuses on GHG emissions associated with the apparel industry in Sri Lanka, a key player in the global apparel and textile supply chain. The study focuses on assessing the GHG emissions of the industry, developing a decarbonization strategy aligning with the Science-Based Targets Initiative's guidelines and analyzing environmental, social, and economical impacts of the decarbonization. In the study, GHG emissions of Martex M F G (Pvt) Ltd, a leading tier 1 and tier 2 apparel manufacturing and processing company in Sri Lanka, have been quantified according to the guidelines of the GHG protocol. With a comprehensive GHG inventory that covers scope 1, 2, and 3, a decarbonization strategy has been developed, which can be applied across the industry in order to achieve the Science-Based Targets Initiative's near-term targets of a 45% reduction of scope 1 and scope 2 emissions and a 50% reduction of scope 3 emissions by 2030. During the study, it was observed that the supply chain takes the major fraction of the GHG inventory and it was given special consideration when developing the decarbonization strategy. Decarbonization methods such as transferring to low-carbon-intensive fuels, procurement practices with sustainability certifications, product sustainability certifications, and utilizing solar energy have been identified and analyzed in the Sri Lankan context. This research outlines an applicable strategy for the apparel industry stakeholders in Sri Lanka to promote decarbonization, which will help the Sri Lankan Apparel Industry to gain wide global recognition by reducing environmental impact while approaching markets with higher values that prioritize the environment.

Keywords: Apparel; Decarbonization; Greenhouse Gas Emission; Net-zero; Science Based Targets Initiative; Sustainability

ICSBE25_386

ASSESSING CLIMATE CHANGE IMPACTS ON STREAMFLOW AND FLOOD RISKS: AN INTEGRATED MODELLING APPROACH FOR THE NILWALA RIVER BASIN, SRI LANKA

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Abstract: Climate change impact assessment at the watershed scale is critical for ensuring sustainable water resources planning and management. The Nilwala River Basin (NRB) in southern Sri Lanka is highly flood-prone due to its steep upper basin and low-lying coastal floodplains, making it particularly vulnerable to changes in precipitation extremes. This study introduces an integrated framework that combines climate modelling, hydrological simulation, hydraulic modelling, and GIS-based risk assessment for the Sri Lankan context. Precipitation projections from CMIP6 under SSP1-2.6 and SSP5-8.5 scenarios were bias-corrected using the Quantile Mapping and analysed for three future periods: Near Future (2030–2052), Mid Future (2053–2077), and Far Future (2078–2100). A calibrated HEC-HMS model (NSE = 0.972, RMSE = 0.2) was employed to generate outflow hydrographs for the Upper Nilwala River Basin, which served as boundary conditions for the HEC-RAS 2D hydrodynamic model of the Lower Nilwala River Basin. Simulations indicate that the discharge at Pitabaddara is projected to increase by 34.11% during the far future period under the SSP5-8.5 scenario, corresponding with a projected precipitation increase of up to 27.8% by the late century. The HEC-RAS model successfully reproduced the 2017 flood extent, with a moderate overall agreement between the observed and simulated extents (Critical Success Index = 40.4%). Risk mapping identified Matara and the surrounding floodplains as the most exposed and vulnerable areas. The results demonstrate the importance of emission pathways in shaping future flood risk and provide a transferable framework to support climate-resilient water resources planning in Sri Lanka.

Keywords: Climate Change; Flood Risk Mapping; HEC-HMS; HEC-RAS; Nilwala River Basin

ICSBE25_490

COMMUNITY RESILIENCE AND CLIMATE RISK: AN ANALYSIS OF SOCIAL ADAPTATION PRACTICES

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Abstract: Climate change has emerged as one of the greatest global challenges, intensifying the frequency and severity of extreme weather events and creating new risks for vulnerable communities. As climate-related hazards such as floods, droughts, and cyclones increase, understanding community resilience and adaptation practices has become essential for ensuring long-term sustainability. This study undertakes a secondary data analysis of community-based adaptation practices and resilience-building strategies documented in scholarly literature, institutional reports, and global datasets. By systematically reviewing and analysing secondary sources, including data from the Intergovernmental Panel on Climate Change (IPCC), World Bank, UNDP, and peer-reviewed studies. This research categorizes adaptation practices and evaluates their effectiveness across diverse social and geographical contexts. Findings indicate that adaptation practices often rely on a combination of traditional knowledge, social capital, livelihood diversification, and institutional support. While many communities demonstrate remarkable innovation in coping with climate risks, limitations such as inadequate resources, policy gaps, and social inequalities hinder resilience outcomes. The study highlights that women, indigenous groups, and marginalized populations often contribute unique adaptive strategies yet remain underrepresented in formal policy frameworks. This analysis concludes that strengthening community resilience requires integrating grassroots practices into climate policy, improving access to resources, and addressing structural inequalities. By mapping adaptation practices from existing data, the research not only underscores the importance of social dimensions in resilience-building but also identifies knowledge gaps that future primary research should explore.

Keywords: Climate Change; Climate Risk; Community Resilience; Social Adaptation Practices

ICSBE25_495

CLIMATE RISK ASSESSMENT IN THE BUILT ENVIRONMENT: AN EVIDENCE-INFORMED REVIEW WITH SRI LANKAN CASE STUDIES, REGIONAL COMPARISONS, AND A WAY FORWARD

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Abstract: Climate Risk Assessment (CRA) in Sri Lanka's built environment has advanced significantly, supported by national policies such as the National Adaptation Plan (2016 - 2025; updated to 2034), Nationally Determined Contributions (2021), and the Third National Communication (2022). This review synthesizes evidence across housing, transport, water, energy, coastal, and urban systems to examine how hazard, exposure, and vulnerability dimensions are operationalized. Insights from the presentation and full paper confirm that while Sri Lanka demonstrates strong progress in flood, coastal, and landslide risk assessments, gaps persist in systematic evaluation of heat stress, compound hazards, and urban heat island effects. Regional comparisons with South and Southeast Asia (India, Bangladesh, Maldives, Thailand, Philippines, Vietnam) highlight feasible pathways for strengthening CRA through standardized toolkits, improved data governance, and integrated institutional mechanisms. The paper proposes a phased roadmap, near, medium, and long-term, to mainstream CRA into planning approvals, building codes, and financing systems, thereby supporting Sri Lanka's transition toward a climate-resilient built environment.

Keywords: Adaptation; Built Environment; Climate Risk Assessment; South Asia; Sri Lanka; Urban Resilience

ICSBE25_544

GAPS IN MAXIMIZING SOLAR ENERGY UTILIZATION IN APPAREL MANUFACTURING FACILITIES: A CASE STUDY OF HIRDARAMANI CUT-AND-SEW FACILITIES

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Abstract: The apparel sector in Sri Lanka is a key contributor to economic growth and employment, but is also energy-intensive, relying heavily on grid electricity with associated greenhouse gas emissions. To address climate and sustainability concerns, many apparel manufacturers have installed rooftop Solar Photovoltaic (PV) systems. However, solar energy utilization remains suboptimal due to structural constraints, restrictive metering systems, lack of storage solutions, and misaligned operational schedules. This study investigates electricity consumption, solar generation, on-site consumption, and export patterns across seven Hirdaramani cut-and-sew facilities in 2024: Kuruvita, Kahathuduwa, Mullaitivu, Eheliyagoda, Seethawaka, Mihila, and Vavuniya. Data were collected from Ceylon Electricity Board bills and facility meters, validated against internal records, and analyzed to quantify gaps in solar utilization. Potential coverage of total electricity demand under full solar adoption was also estimated to evaluate cost savings and carbon reduction opportunities. Results indicate significant disparities in solar utilization: Seethawaka achieved the highest on-site consumption, potentially covering over 90% of its electricity demand, whereas Kuruvita and Vavuniya exhibited minimal utilization despite substantial solar generation. Key barriers include insufficient PV capacity relative to demand, building structural limitations, restrictive metering, operational scheduling misalignment, and lack of energy storage. The study proposes strategies to optimize solar utilization, including PV capacity expansion, structural retrofits, energy storage integration, operational alignment with generation, financial mechanisms, and sector-wide collaboration. Implementing these measures can enhance renewable energy use, reduce reliance on fossil-based electricity, and strengthen the apparel sector's sustainability performance in Sri Lanka.

Keywords: Apparel Manufacturing; Energy Efficiency; Renewable Energy; Solar Energy; Sri Lanka; Sustainability

ICSBE25_559

ASSESSMENT OF GASEOUS EMISSIONS FROM SHIELDED METAL ARC WELDING: EFFECTS OF ELECTRODE TYPE AND CURRENT PARAMETERS

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Abstract: Arc welding is a metal bonding method that has been used in small metal industries to large-scale construction works. For the welding process, welders need to have good skills and experience due to hazards, including electric shocks and burns. However, the welding process can emit a lot of harmful gases to both humans and the environment, which is not well-focused on during industrial activities. These gases are basically CO, CO_2, and NO_x. Even though there have been several studies conducted to develop gas fumes to remove such gases, the number of studies conducted to analyze such emissions is minimal. This study is focused on filling this research gap using a custom-built gas emission collector and the high-end Testo 350 high end gas analyzer. This research has been carried out for five commonly used welding rods in Sri Lanka at three welding currents (70 A, 80 A, and 90 A). During the process, the highest CO and CO_2 emission of 35 ppm was reported for SWG8 (6013) and 0.55 IR% for SWG10(6013). The highest NO emission was recorded for SWG8 (6013) at 90 A. The study has revealed that the emission densities of CO, CO_2, NO, and NO_x are not at a damaging level to the human body, but not at a negligible level. Since then, it is recommended to use technologies such as emission fumes to provide additional protection to workers and use standard welding rods such as SWGG12(E 308L-16).

Keywords: Emission Gases; Gas Analysis; Welding; Welding Currents

CONCRETE TECHNOLOGY AND HIGH-PERFORMANCE CONCRETE

ICSBE25_033

INVESTIGATION OF THE STRUCTURAL PERFORMANCE AND APPLICABILITY OF PRECAST CONCRETE ELEMENTS WITH FRP BOAT WASTE

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Abstract: The disposal of Fiber Reinforced Plastic (FRP) boat waste presents a significant environmental challenge due to the absence of effective recycling methods. This study investigates the incorporation of FRP boat waste into precast concrete elements, specifically paving blocks. The main focus of the study is to enhance the mechanical and durability properties of concrete while promoting sustainable waste management. Experimental work has been done by incorporating FRP waste in concrete at varying proportions (0.25%, 0.50%, 0.75%, and 1.0% by volume) as an additive. Then its effect on compressive, tensile, and flexural strengths, as well as impact resistance, water absorption, and acid attack resistance, have been tested. The results indicated that a 0.50% FRP content enhances early-age compressive strength and impact resistance. However, incremental addition of FRP reduced 28-day compressive, tensile and flexural strengths, attributed to weak interfacial bonding between FRP fibers and the cement matrix. The study also revealed a decrease in water absorption with higher FRP content, demonstrating improved moisture resistance. Based on these findings, paving blocks with 0.50% FRP content are recommended for pedestrian pathways and other low-load applications, where impact resistance and durability in moisture-prone environments are critical. Future studies should focus on improving FRP-concrete bonding to enhance mechanical performance and exploring the economic feasibility of large-scale FRP-incorporated concrete applications. The findings provide valuable insights into the structural applicability of FRP-modified concrete, demonstrating its potential as an environmentally friendly solution for both waste management and sustainable construction.

Keywords: Durability Properties; FRP Boat Waste; FRP Incorporated Concrete; Mechanical Properties; Paving Blocks

ICSBE25_055

THE EFFECT OF SEA WATER ON MICROSTRUCTURAL AND MECHANICAL PROPERTIES OF CEMENT PASTE WHEN USED IN MIXING AND/ CURING

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Abstract: The construction industry is under growing pressure to embrace sustainable water alternatives as freshwater scarcity becomes a global concern, particularly in coastal and arid regions. One promising way to lessen reliance on freshwater resources is the utilization of seawater in cementitious materials. This study presents a critical review and experimental investigation into the effects of seawater on microstructural and mechanical properties of cement paste, particularly when seawater is used for mixing and/ or curing. The study focuses on the resulting properties of cement paste, including its short compressive strength as well as porosity. Existing studies have shown that porosity and compressive strength are affected by three factors such as curing days, mixing and curing process, and water-to-cement ratio. To explore these factors, 360 cement paste cubes were cast using three different water-to-cement ratios (0.3, 0.4 and 0.6) and subjected to four different mixing and curing conditions (1. mix with fresh water and curing at fresh water, 2. mix with fresh water and curing at sea water, 3. mix with seawater and curing at fresh water 4. mix with sea water and curing at sea water) and tested at five curing durations (3, 7, 14, 28, 56 days). The results were analyzed to determine the corresponding significance of each component and to identify the conditions which promote sustainable performance in coastal environments. The primary findings revealed that pastes containing seawater had greater strength at an early age, particularly when exposed to SF conditions (seawater-mixed, freshwater-cured). However, samples that were cured in seawater displayed increased porosity and decreased strength as a result of being exposed to chloride, sulfate, and magnesium ions. Therefore, if the right mix design and mitigation techniques are used, seawater may be a good substitute in non-reinforced or mass concrete applications, especially in coastal zones.

Keywords: Compressive Strength; Curing Condition; Hydration Period; Mixing Condition; Porosity

ICSBE25_116

REDUCING CONCRETE WASTE IN HIGH-RISE BUILDING CONSTRUCTION IN SRI LANKA: A PROCESS-RELATED COMPARATIVE ANALYSIS OF IN-SITU, READY-MIX, AND PRECAST SYSTEMS

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Abstract: Concrete remains one of the most extensively utilized construction materials worldwide, particularly in the development of high-rise structures. Its pervasive use, however, contributes significantly to construction material waste and environmental degradation. While the adoption of different concrete systems and context-specific processes offers potential for minimizing waste, the extent to which process-related differences influence concrete waste generation across various systems, such as in-situ, ready-mix, and precast, remains underexplored. This study aims to examine and compare the concrete wastage associated with these three construction methods within the context of Sri Lankan high-rise building projects and proposes strategic recommendations to mitigate concrete waste generation. Consequently, a comprehensive literature review was conducted, followed by a qualitative research approach. Data were collected through a series of 12 semi-structured interviews involving individuals with expertise in quantity surveying and civil engineering. Data analysis was conducted through manual content analysis to identify noteworthy areas of waste, their causes, and potential solutions. The research identified that in-situ concrete generates the most waste, with the majority of it resulting from poor workmanship, climatic factors, and inadequate material handling. Ready-mixed concrete waste is often generated by over-ordering and delays in transport, whereas precast concrete produces minimal waste despite being affected by design, transport, and installation complications. A strategic framework is proposed from the findings, which outlines the causes of waste generation at each stage of concrete production and systematically maps the strategies to overcome them. The findings recommend the expanded application of precast concrete systems, along with in situ and ready-mix concrete, to leverage the quality and precision of precast systems in reducing waste. Moreover, the strategic recommendations emphasize the application of lean principles in reducing waste generation in in situ and ready mix systems. Further research is suggested to evaluate and rank the strategies to prioritize their implementation in practice.

Keywords: Concrete Waste; High-rise Buildings; In-situ Concrete; Precast Concrete; Ready-mixed Concrete

ICSBE25_211

UTILIZATION OF CERAMIC DUST AS A SUPPLEMENTARY CEMENTIOUS MATERIAL IN PERVIOUS CONCRETE WITH VARYING UNIFORM AGGREGATE SIZES

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Abstract: Rapid urbanisation has led to the widespread formation of impervious surfaces, resulting in urban heat, reduced stormwater infiltration, and increased flooding. Additionally, the disposal of ceramic dust as a by-product of industrial processes is confronted with environmental problems. To mitigate such issues, the current research examines the potential of applying ceramic dust as a Supplementary Cementitious Material (SCM) in pervious concrete to ascertain the effect of various uniform aggregate sizes on its performance. Incorporation of ceramic dust at partial replacement levels caused a reduction in compressive strength compared to the control mix, but with good permeability and rate of absorption, along with the added benefit of cement content and cost of material savings. The experiment evaluated the impact of various uniform aggregate sizes on pervious concrete performance and proved that the permeability, strength, and absorption were considerably impacted by the aggregate size. Finer aggregates decreased the absorption, while large aggregates increased it. While the uniform aggregates were the interest, comparison with graded aggregates presented relatively well-balanced performance of all the key parameters. The application of ceramic dust-based paving blocks in sidewalks and parking lots provides an environmentally friendly solution that minimizes environmental impact. The treatment effectively turns waste into a valuable resource, and it is congruent with the idea of a circular economy. Application of ceramic dust in lightweight pervious concrete provides a feasible way for improving urban infrastructure building, preventing the urban heat island effect, and reducing waste.

Keywords: Aggregates; Alternative Materials; Impervious Surfaces; Particle Size; Permeability

ICSBE25_260

EFFECTS OF STEEL-POLYPROPYLENE FIBER REINFORCED CONCRETE ON FLEXURAL TENSILE STRENGTH AND COMPRESSIVE STRENGTH

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Abstract: Fiber Reinforced Concrete (FRC) is a composite material consisting of concrete reinforced with uniformly dispersed discontinuous fibers, enhancing its mechanical properties and durability. FRC finds extensive application in sprayed concrete, slabs, pavements, floor screeds, and precast tunnel segments, with its performance largely influenced by fiber type and dosage. This study focuses on precast tunnel segments, which conventionally employ steel fibers to improve structural capacity. However, a persistent challenge in these segments is the development of tensile cracks during demoulding, transportation, and installation via Tunnel Boring Machines (TBMs). These stress-induced microcracks compromise structural integrity, leading to water infiltration and potential failure. To mitigate this issue, the present research investigates the efficacy of Hybrid Fiber Reinforced Concrete (HFRC), incorporating both steel and polypropylene (PP) fibers. A constant steel fiber dosage of 40 kg/m^3 was maintained throughout the study, while PP fiber content was varied (0.5 kg, 0.8 kg, 1.1 kg, 1.5 kg, and 1.8 kg per cubic meter) to optimize flexural tensile and compressive strengths. A total of six concrete mixes were prepared, and six beam specimens for each mix were tested for flexural tensile strength, while six cube specimens were tested for compressive strength, giving a total of 72 samples. Compressive strength was measured at 7 and 28 days, while the tensile strength was determined at 28 days. The weight of PP fibers was the independent variable, while the response variables were compressive and tensile strength. These results confirm the huge potential of hybrid fiber systems in terms of mechanical performance and durability in precast tunnel segments. The results have been useful to engineers and designers in the construction industry, especially where these structures are to be applied under conditions that require structural strength and durability, thus contributing toward stronger and more sustainable concrete infrastructures.

Keywords: Compressive Strength; Crack Mouth Opening Displacement; Flexural Tensile Strength; Hybrid Fibre Reinforced Concrete; Polypropylene Fibre Reinforced Concrete; Steel Fibre Reinforced Concrete

ICSBE25_388

COMPARATIVE ANALYSIS OF LIGHTWEIGHT PRECAST CONCRETE WALLS FOR LOAD-BEARING AND NON-LOAD-BEARING APPLICATIONS

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Abstract: Modern construction methods must be sustainable and efficient. To meet these requirements, lightweight precast concrete wall systems are being explored as an alternative to traditional masonry. These precast walls reduce structural loads, improve thermal performance, and reduce construction time. The most effective wall materials combine low density with adequate strength and durability. Lightweight panels have been developed and researched in different contexts; for example, Lightweight concrete panels can be made of EPS, foam, fly-ash, AAC, etc. Their density ranges from 800-2000 kg/m^3 and compressive strength varies from 5-40 MPa, but there has been no proper comparison of their applicability and performance. The purpose of this study is to find the most appropriate lightweight material for different applications based on their performance. This study investigated five lightweight concrete panels: Expanded Polystyrene-based, High-Density Polyethylene-based, Foam Concrete, Fly-Ash-based, and Ferrocement-based concrete panels. Their performance was analyzed in terms of compressive strength, density, thermal conductivity, and flexural strength. Experimental results from past literature were collected and analyzed using a Multi-Attribute Decision-Making framework with the Simple Additive Weighting method. It was found that EPS concrete with silica-fume replacement achieved compressive strengths of up to 60 MPa at densities of 1200-1800 kg/m^3, making it suitable for structural walls. Foam concrete has good thermal insulation (0.15-0.35 W/m·K) but has low strength, making it only suitable for non-structural applications. At 10-20% replacement, HDPE concrete panels have exhibited improved durability with reduced density; however, strength has been decreased as the HDPE volumes increase. Adding fly ash has improved long-term strength and sustainability, especially when mixed with bottom ash. Ferrocement panels with EPS or aerated cores showed higher fire resistance (up to 120 minutes) and structural integrity in thin-walled systems. The results of the study could be utilized for choosing the most appropriate lightweight concrete panel type based on the required performance.

Keywords: Expanded Polystyrene (EPS); Ferrocement; Fly Ash; Foam Concrete; High-Density Polyethylene (HDPE)

ICSBE25_405

APPLICABILITY OF ACI MIX DESIGN GUIDELINES FOR HIGH-STRENGTH CONCRETE WITH ALTERNATIVE AGGREGATES

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Abstract: Concrete having a compressive strength higher than 41 MPa at 28 days is defined as High Strength Concrete (HSC) as per the American Concrete Institute (ACI) guidelines. HSC is increasingly used in modern construction due to its superior mechanical performance, durability, and space efficiency. Traditionally, HSC is produced using conventional aggregates such as natural river sand for fine aggregate and crushed stone or gravel for coarse aggregate. However, the environmental impact of quarrying and the depletion of these natural resources have created a critical need for sustainable alternatives. Different studies have utilized alternative aggregates such as Recycled Concrete Aggregate (RCA), Manufactured sand (M-sand), copper slag, nickel slag, steel slag and bottom ash in developing HSC. Most of these studies have developed the mix designs based on previous literature mix proportions and trial-and-error procedures. There is a well-defined mix design guideline in ACI 211.4R-08 for HSC with conventional aggregates. This study evaluates whether the same guideline could be applicable for HSC with alternate aggregates. This study used a comparative deviation analysis to evaluate differences between published experimental mix proportions and ACI predicted values for various fine and coarse aggregate replacements. Coarse aggregate replacements demonstrated better overall alignment, with chemically treated RCA showing deviations below 15% and nickel slag demonstrating strong compatibility across all components, with an overall average deviation of less than 10%. By contrast, untreated RCA exhibited variations exceeding 20% across multiple parameters. Fine aggregate replacements presented greater challenges, with the performance of M-sand being highly dependent on fineness modulus and particle characteristics. Industrial by-products yielded mixed outcomes, as copper slag showed deviations in the 1-18% range while bottom ash displayed deviations exceeding 30%. The ACI 211.4R-08 method shows variable compatibility with alternative aggregates and requires tailored modifications for accurate mix proportioning. The method works well for some alternative aggregates, like nickel slag, but needs significant adjustments for others like bottom ash and high-absorption RCA.

Keywords: ACI 211.4R-08; Alternative Aggregates; High-strength Concrete; Mix Design; Recycled Aggregates

ICSBE25_579

THERMAL CONDUCTIVITY OF CONCRETE: INFLUENCE OF MATERIAL COMPOSITION, DENSITY, AND MOISTURE CONTENT - A REVIEW

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Abstract: Concrete is one of the most widely used construction material used now a days. The thermal performance of concrete depends on Thermal Conductivity (TC), which affects the energy consumption of concrete-based building constructions. The higher the TC paves the way to higher the building energy consumption ultimately tend to huge greenhouse gas emissions, indirectly to the environment increasing global warming. It is important to study ways of reducing concrete TC to reduce the energy consumption of buildings. Concrete TC depends on various factors like moisture content, density, concrete composition, temperature etc. This study is to understand the currently available studies of concrete TC, especially the effect of moisture content, material composition and density on concrete TC and approximately estimate better concrete technologies that incorporate with less TC of concrete to reduce internal energy consumption, ultimately reducing environmental pollution by greenhouse gases. The methodology involved a comprehensive review of research articles focusing on the influence of mix proportions, aggregate characteristics, porosity, density, moisture, temperature and modern additives on TC. Results show that the TC increases with higher coarse aggregate content, density, and moisture contents, while light-weight aggregates, greater porosity and supplementary cementitious materials like fly ash, silica fumes reduce temperature rises, lowers the TC of concrete. Although this reduces TC, the effect on concrete strength needs to be considered when designing. TC of concrete measuring methods like Steady state methods and Transient state methods were discussed based on their speed, accuracy and application. Numerical methods and machine learning approaches for TC prediction were discussed. The study concludes that despite significant progress, research gaps remain in evaluating the combined effects of reinforcement, thermal bridging and long-term environmental impacts. Future investigations should focus on optimizing mix designs for low TC without compromising strength, integrating sustainable materials

Keywords: Concrete; Energy Efficiency; Mix design; Thermal Conductivity; Thermal Performance

BRIDGE DESIGN, CONSTRUCTION, AND MANAGEMENT

ICSBE25_068

EFFECT OF SAND MINING ON SCOURING AROUND THE BRIDGE PIERS IN SRI LANKA

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Abstract: The Scour formed around the piers of bridges built across flowing water, such as rivers, are a critical factor in the strength of the bridge foundation. These scours are influenced by hydrological characteristics and the amount of sediments(sand) at the bottom of the watercourse. This sand maintains the depth of these scours in equilibrium, preventing them from continuously being excavated. However, in countries like Sri Lanka, illegal sand mining is reducing the amount of sand in riverbeds. This can disrupt the balance maintained by sediments with scour. this research investigates the effect of sand mining on scour development around bridge piers. The Kelanisiri Bridge over the Kelani River, one of the largest rivers in Sri Lanka, was used for this study because it is a good introduction to the risks posed by the Kelani River, which is prone to flooding, sand mining activities, and bridges built across it. Here, laboratory experiments were conducted using a scaled physical model under controlled conditions of the bridge and river system to simulate and monitor scour processes under a sand mining incident. This test was conducted in a flume and was conducted under two test conditions: one as a scour study without sand mining and one as a scour study with sand mining. the gradient of the flow–scour depth relationship was steeper in the sand mining case (1.1141) compared to the without sand mining case (1.0377), this confirmed sand mining accelerates scour development under similar hydraulic conditions. Sand mining around bridge piers is causing the scour to deepen, and the main reason for this is that the sediment has not reached equilibrium. A 2D HEC-RAS model was also used and showed good agreement with the laboratory results. Statistical analysis using R^2 and RMSE was performed to quantify the agreement between physical and numerical results. The results show that sand mining increases scour risk.

Keywords: Bridge Scour; HEC-RAS; Physical Modelling; Sand Mining; Sediment Transport

ICSBE25_427

ENHANCING SERVICE LIFE OF CONCRETE STRUCTURES USING ZINC-RICH EPOXY PRIMER AND CONCRETE SURFACE TREATMENTS

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Abstract: The corrosion of embedded mild steel is a significant concern for the service life performance of concrete structures. The expansive nature of corroded steel leads to concrete delamination and spall, impacting the load-carrying capacity of structural members. To enhance the durability, the use of Zinc-rich epoxy coatings for steel reinforcement and concrete surface treatments is considered. This study was initiated to investigate the performance of such concrete preservation strategies using a modified accelerated corrosion test version of the Bureau of Standards M-82 Protocol. Five test cases were developed using ten reinforced concrete slab specimens. Each specimen was subjected to accelerated corrosion through NaCl ponding. Repairs included two patching materials, Latex Modified Concrete (LMC) and a regular concrete mix with Type I cement, along with steel protection via zinc-rich epoxy primer (ZINC CLAD® 4100), and concrete surface treatments, a silane penetrating sealer (Protectosil® BH-N) and an elastomeric coating (Benjamin Moore Ultra Spec® Flat 0359). Results showed that patch repair alone, or in combination with sealers, provided limited corrosion protection to the repaired region only. In contrast, test cases utilizing Zinc-rich epoxy primer in conjunction with concrete coatings exhibited significantly lower corrosion activity in both the repaired and adjacent areas. Integrated current and half-cell potential data confirm that the combination of patch repair, Zinc-rich epoxy primer, and elastomeric surface coating provides the most effective preservation for extending the service life of concrete structures.

Keywords: Concrete Surface Treatment; Concrete; Corrosion Protection; Corrosion Testing; Patch Repair; Zinc-rich Epoxy Primer

ICSBE25_483

18-DEGREE SKEW NETWORK ARCH BRIDGE RESPONSE UNDER AMBIENT TEMPERATURE

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Abstract: An 18-degree skew, 245 ft long, 96.5 ft wide, unbraced, network tied-arch bridge was designed to carry the 2nd Avenue traffic over the Interstate (I) 94 in Detroit, Michigan. The bridge construction was completed and declared open on October 27, 2023. An instrumentation system was designed and installed in the bridge to (i) monitor and record strains in major components during construction to determine the state of stress after construction, (ii) monitor and record the change in strains during service life to support bridge maintenance and load rating decisions, and (iii) collect adequate data to verify design assumptions. The sensors installed in the bridge monitor both temperature and strains. To evaluate the relationship between thermal effects and structural response, a statistical correlation matrix was developed using two years of strain and temperature data. Pairwise correlations were computed both within cross-sections and between different cross-sections of tie girders, end diaphragms, and arch-knuckle connections. The analysis identified significant correlations between strains in these structural components, as well as between temperature variations and strain responses, providing insight into global and local behavioural patterns of the bridge. This presentation describes the bridge configuration, construction process, instrumentation system, statistical analysis results, and the bridge response under ambient temperature measured during the two years following construction.

Keywords: Correlation; Heat Map; Instrumentation; Network Arch Bridge; Statistical Analysis; Temperature

ICSBE25_584

FOUNDATION MODEL ADAPTATION WITH ACTIVE LEARNING FOR LABEL-EFFICIENT CORROSION SEGMENTATION: A REVIEW OF EXISTING DEEP LEARNING MODELS AND PROPOSAL FOR A LABELLING SOLUTION

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Abstract: Manual pixel-level annotation of corrosion in steel bridge imagery represents a critical bottleneck in deploying deep learning-based structural health monitoring systems. Traditional Convolutional Neural Networks (CNNs) and semantic segmentation models require thousands of expert-labeled images, which is cost-prohibitive for civil engineering applications. This paper reviews existing deep learning approaches for corrosion detection and segmentation, systematically analyzing their annotation requirements, generalization capabilities, and deployment constraints. Key architectures, including U-Net, Mask R-CNN, DeepLabV3+, and YOLO variants, are evaluated across multiple dimensions: label efficiency, computational cost, cross-domain robustness, and practical applicability to bridge inspection workflows. Recent advances in foundation models-particularly the Segment Anything Model (SAM)-offer pretrained, general-purpose segmentation capabilities that can be adapted to specialized domains with minimal labelled data. When combined with active learning strategies that intelligently query uncertain regions for expert annotation, foundation model adaptation presents a transformative solution to the labelling challenge. This paper proposes a conceptual framework integrating SAM-based pseudo-label generation, uncertainty-guided active region querying, and iterative model refinement to achieve corrosion segmentation performance comparable to fully-supervised methods while reducing annotation effort by 70-80%. The proposed approach addresses critical gaps in current practice: scalability to diverse bridge types, rapid adaptation to new damage patterns, and feasibility for resource-constrained transportation agencies. This work establishes a research agenda for label-efficient AI in infrastructure inspection and provides a foundation for empirical validation studies.

Keywords: Active Learning; Bridge Inspection; Corrosion Segmentation; Deep Learning Foundation Models; Label Efficiency

ICSBE25_654

BUCKLING CAPACITY OF I-BEAMS WITH WEB OPENINGS: AN ANALYTICAL APPROACH

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Abstract: I-beams with web openings can fail through various modes, including local buckling, web shear buckling, Vierendeel mechanism, lateral-torsional buckling, and lateral-distortional buckling. Among these, Lateral-Torsional Buckling (LTB) is one of the principal failure modes for beams with open cross-sections. Most design guidelines for LTB in beams with web openings adopt the 2T approach; however, the selection of buckling curves varies among different proposals. This method is based on experimental studies referenced in the literature and reiterated in Eurocode 3 and it is conservative. To improve the accuracy of the analytically predicted capacity, this paper proposes another analytical approach to predict the lateral-torsional buckling capacity of doubly symmetric I-beams with web openings. The approach introduces a new formula for the elastic critical moment of LTB, derived using the energy method. The concept is based on equating the strain energy stored in a beam during LTB to the external work done by the applied loads. This formula is then used to determine the non-dimensional slenderness, which in turn defines the design capacities for LTB moments in beams with web openings and varying cross-sections. The accuracy of the proposed method is validated through comparisons with experimental and numerical results for beams with web openings.

Keywords: Beam with Web Openings; Elastic-critical Moment; Energy Method; Lateral-torsional Buckling

ICSBE25_655

FATIGUE STRENGTH DEGRADATION OF TUBULAR JOINTS EXPOSED TO SEVERE CORROSIVE ENVIRONMENTS

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Abstract: Fatigue assessment of tubular joints in corrosive environments is generally performed by using fatigue strength curves, which are obtained by applying the Environmental Reduction Factor (ERF) to the relevant fatigue strength curve in air. The average ERF value has been determined by very scattered corrosion fatigue test results and hence, a constant slope is proposed for the whole region of fatigue life. However, this assumption contradicts the actual corrosion-fatigue behaviour of steels, where the difference between fatigue lives in corrosive and non-corrosive environments is negligible in the low-cycle fatigue region but becomes significant in the very-high-cycle fatigue region. To address this limitation, a novel fatigue strength curve is proposed in this paper to predict the fatigue life of tubular joints exposed to severe corrosive environments such as marine or seawater. The standard fatigue strength curves of tubular joints in air are then modified to obtain stress-life fatigue curves applicable to tubular joints exposed to marine or seawater environments. The severe corrosive environment-dependent parameters of the proposed stress-life fatigue strength curve are determined in a mesoscopic level investigation based on corrosion-fatigue test results of various steel specimens tested both in air and seawater. The proposed curve formulation is validated through comparison with full-scale fatigue test results of different types of tubular joints tested under free corrosion in seawater and subjected to various loading conditions. The results confirm the validity of the proposed fatigue strength curve and demonstrate its applicability and advantages over current design practices.

Keywords: Corrosive Environments; Fatigue; S-N curve; Tubular Joints

ICSBE25_657

IMPROVING THE ARCHIVAL AND RETRIEVAL EFFICIENCY OF BRIDGE INSPECTION IMAGERY DATA WITH LEARNING-BASED COMPUTER VISION MODELS

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Abstract: Highway agencies are storing large volumes of bridge inspection images, which create new opportunities and logistical challenges. While these images hold information about structural components and conditions, the lack of standardized naming systems, organized metadata, and consistent categorization reduces their usefulness for searching, analysis, and integration into asset management systems. An evaluation of current image storage and upload practices among highway agencies identified several key issues hindering the effective and efficient use of rich data in these images for bridge management decision-making. To address these limitations, a computer vision-based image processing tool was developed for seamless integration into existing highway agency workflows. This tool uses deep learning techniques such as classification, segmentation, and object detection to analyze archived bridge inspection images and serves as a standalone batch-processing tool that produces structured outputs. This tool was developed by combining EfficientNet-B7 for image-level classification and YOLOv12 for instance-level segmentation. EfficientNet-B7 detects major bridge components such as columns, piers, abutments, and wingwalls, while YOLOv12 localizes and segments these components within each image. Inference on unseen inspection data achieved an accuracy of about 80%. Model training included data augmentation, hyperparameter tuning, and learning rate scheduling to enhance generalization and stability, with performance metrics monitored throughout. For each processed image, the system creates a corresponding text file or Excel sheet that includes the image name, predicted bridge components, detected traffic control devices, segmented regions with bounding box coordinates, and extracted sign text using OCR. Structure identification numbers and inspection dates are added from existing records. This approach standardizes terminology across inspection datasets, simplifies search and retrieval, and eliminates the need for manual image review. Metadata filtering enables users to quickly find relevant images, while the structured outputs can be linked with agency-specific large language models to support automated querying, reporting, and data extraction.

Keywords: Bridge; Computer Vision; EfficientNet; Inspection; YOLO

WATER TREATMENT TECHNOLOGIES; SUSTAINABLE WATER AND WASTEWATER MANAGEMENT

ICSBE25_003

SMALL SCALE WASTE WATER TREATMENT SYSTEM IN SINGLE HOUSES IN SRI LANKA

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Abstract: Water, an indispensable resource for both flora and fauna, is crucial for sustaining life. Wastewater, comprising utilized water contaminated with various substances like human waste, food residues, oils, soaps, and chemicals, originates from diverse household sources such as sinks, showers, toilets, and appliances like washing machines and dishwashers. Treating wastewater is vital for environmental preservation and public health. The primary objective of wastewater treatment is the elimination of suspended solids before discharging the remaining water, termed effluent, into the environment. The focus of this project is wastewater treatment in individual residences, a concern addressed through various methods globally. However, our initiative aims to introduce the bio-digester system for household wastewater treatment across Sri Lanka. Household water consumption is often excessive, resulting in wastage without proper treatment. Surplus treated wastewater necessitates environmentally conscious disposal methods. While connecting to municipal sewers is common, it poses environmental risks, including overflow during heavy rains and potential blockages. Moreover, different types of wastewater—greywater, blackwater, and stormwater runoff—contain distinct contaminants, requiring specific treatment approaches and disposal considerations. Our bio-digestor system offers a versatile solution capable of treating various types of wastewater efficiently. Unlike some systems requiring extensive infrastructure modifications, ours seamlessly integrates into existing setups with minimal adjustments, making it accessible for households worldwide, regardless of location or environmental conditions. Extensive research, including surveys, field studies, and experiments, has bolstered our confidence in the feasibility and effectiveness of the Bio Digestor system. We anticipate its successful implementation and foresee its multifaceted benefits for individuals and communities, a topic we will delve into further in subsequent discussions.

Keywords: Bio Digestor System; Effluent; Environmental Preservation; Household Wastewater; Wastewater Treatment

ICSBE25_048

CONSTRUCTED WETLANDS FOR DOMESTIC WASTEWATER TREATMENT UTILIZING CONSTRUCTION WASTE AS SUBSTRATE MEDIA

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Abstract: The rapid expansion of construction activities over the world has led to the generation of large quantities of construction waste. Concurrently, urbanization has significantly increased domestic wastewater production. Addressing both issues requires a sustainable, eco-friendly solution. This study explores the use of construction waste as an alternative substrate media in Constructed Wetlands (CWs) for domestic wastewater treatment. This approach not only repurposes construction waste, reducing landfill burden, but also offers a cost-effective, environmentally sustainable solution. Even though few studies have been conducted on the potential application of construction waste as media in CWs, they remain limited, indicating a significant research gap in this area. This study aims to evaluate the effectiveness of demolished bricks, demolished concrete and gravel (serving as the control) for treating synthetic wastewater simulated to domestic wastewater. The experimental set-up consists of six laboratory-scale hybrid CWs, each containing a vertical sub-surface flow (Diameter: 0.45 m, Depth: 0.6 m) and a horizontal sub-surface flow (Length: 0.5 m, Width: 0.35 m, Height: 0.5 m) wetland units in series and arranged to have two replicates for each media type. All six hybrid wetland systems were planted with *Typha angustifolia* and operated at a 20 cm/day hydraulic loading rate using synthetic wastewater. Influent and effluent wastewater samples were collected weekly and tested for pH, electrical conductivity, dissolved Oxygen, Chemical Oxygen Demand (COD) and five-day Biochemical Oxygen Demand (BOD_5). Demolished brick media has a greater potential in removing BOD_5 and COD with average removal efficiencies of 89% and 86%, compared to gravel 86% and 82% and demolished concrete 76% and 77% respectively. These findings highlight the dual benefit of environmental remediation and sustainable resource management.

Keywords: Constructed Wetlands; Construction Waste; Pollutant Removal Efficiency; Synthetic Wastewater

ICSBE25_076

CLOGGING MITIGATION OF VERTICAL SUB SURFACE FLOW CONSTRUCTED WETLAND

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Abstract: Vertical Subsurface Flow (VSSF) Constructed Wetlands (CWs) offer an eco-friendly and cost-effective wastewater treatment. However, their long-term performance can be compromised by clogging, primarily caused by the accumulation of organic and inorganic matter within the pores of substrate media. This study investigated the potential of backwashing as a remediation to mitigate clogging in VSSF CWs while evaluating their treatment performance. Backwashing involves reversing the flow direction and applying a high Hydraulic Loading Rate (HLR) to flush out the accumulated material from the substrate media, specifically focusing on the non-root zone region to preserve the essential plant-microbial interactions responsible for treatment efficiency. The objectives of this study included evaluating the impact of different HLRs on the performance of VSSF CWs, assessing the extent of clogging under different HLRs, and evaluating the effectiveness of backwashing in reducing clogging in VSSF CWs. The experimental set-up consists of three laboratory-scale VSSF CW units, each constructed using 30 cm diameter Perspex tubes filled with 3 - 5 mm granular media, planted with umbrella palm (*Cyperus alternifolius*), and operated at different HLRs of 25, 50 and 80 cm/day, respectively. Samples were collected weekly from the influent and effluent of each unit and tested for five-day Biochemical Oxygen Demand (BOD_5), ammonium (NH_4^+), nitrate (NO_3^-), Total Suspended Solids (TSS), and Fecal Coliform (FC). Head-loss measurement was used as the indicator for clogging detection. Results showed that the wetland unit operated at 25 cm/day HLR achieved the best overall pollutant removal with average removal efficiencies (REs) of 52.9%, 52.2%, 76.7%, 66.6% and 64.4% while 80 cm/day HLR unit showed the lowest REs of 44.5%, 26.8%, 72%, 57.6% and 35% for BOD_5, NH_4^+, NO_3^-, TSS and FC respectively. Head-loss before and after backwashing was observed as (5.0 and 2.8), (6.8 and 3.2) and (7.5 and 3.8) in cm for 25, 50 and 80 cm/day wetland units, respectively. The results demonstrate that backwashing effectively mitigates clogging, enabling the restoration of VSSF CW performance and thereby enhancing their long-term operational sustainability and treatment efficiency.

Keywords: Backwashing; Clogging; Head Loss; Hydraulic Loading Rate; Vertical Subsurface Flow Constructed Wetlands

ICSBE25_106

ASSESSMENT OF RAINWATER HARVESTING SYSTEM SUITABILITY BASED ON WATER QUALITY PARAMETERS IN URBAN WATER MANAGEMENT COLOMBO, SRI LANKA

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Abstract: Urban water scarcity is becoming a bigger issue in developing areas like Colombo, Sri Lanka. Rainwater harvesting offers a decentralized way to help meet water needs. This study evaluates how suitable harvested rainwater is for urban use based on important water quality factors. We collected samples from six locations within the Colombo Divisional Secretariat, each using different roof types, including tile, concrete, and asbestos. We analyzed turbidity, color, pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and *Escherichia coli* (*E. coli*). The results showed that while most physical and chemical factors were within acceptable limits for non-drinking use, we found microbial contamination in all samples. Tile roofs generally produced better quality water, while concrete roofs had higher pollutant levels. The presence of *E. coli* at all sites highlights the need for proper treatment before use. The findings suggest that with the right filtration and disinfection, rainwater collected from rooftops can be a good resource for non-drinking urban use.

Keywords: Rainwater Harvesting; Roof Runoff; Urban Water Management; Water Quality Assessment

ICSBE25_114

UTILIZING DAIRY WASTEWATER AS A GROWTH MEDIUM FOR CULTIVATING *Chlorococcum aquaticum*

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Abstract: This study evaluated the suitability of dairy wastewater as a low-cost alternative medium for cultivating *Chlorococcum aquaticum*, aiming to support both microalgal biomass production and dairy effluent bioremediation. Certain physical (colour, odour) and chemical characteristics (pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and salinity) of raw dairy wastewater were determined using standard methods. Dairy wastewater was diluted to concentrations of 25%, 50%, 75% and 100% using distilled water, while Bold's Basal Medium (BBM) and distilled water were used as control treatments. All treatments were prepared in sterile 100 ml conical flasks, each inoculated with 10 ml of *C.aquaticum* culture. Every two days, samples were analyzed for pH, TDS, EC, and Salinity. Biomass accumulation was quantified using a UV-visible spectrophotometer at 750 nm. The dairy effluent had an off-white colour, emitted an offensive odour, and exhibited a highly alkaline pH (12.97). After 15 days, the pH of the 25% dilution decreased to 8.34, falling within the optimal range for algal growth. Among all treatments, 25% dilution exhibited the highest and most rapid increase in algal growth, compared to BBM, indicating higher biomass production. In comparison, other dilutions showed delayed growth due to stress from higher pollutant and nutrient loads. One-way ANOVA showed a statistically significant difference in biomass across treatments ($P = 0.0003$), with the 25% dilution having the highest algal growth (mean OD = 0.1272) compared to others, as confirmed by Tukey's test ($p < 0.05$). A decrease in TDS (from 636 ppm to 308 ppm) over time reflects nutrient uptake by *C.aquaticum*. A moderate decrease in EC (from 0.87 mS to 0.43 mS) and a decrease in Salinity (from 0.4 ppt to 0.2 ppt) likely reflect ion assimilation by *C.aquaticum*. These findings indicate that 25% dairy wastewater dilution is a cost-effective, nutrient-rich, and statistically validated medium for *C.aquaticum*, enabling sustainable biomass production and partial remediation.

Keywords: Bioremediation; *C.aquaticum*; Dairy Wastewater; Microalgae Cultivation; UV-Vis Spectrometry

ICSBE25_165

RAINWATER HARVESTING AND SUSTAINABLE WATER MANAGEMENT STRATEGIES FOR FLOOD RISK REDUCTION IN THE NEGOMBO URBAN-COASTAL ZONE

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Abstract: Negombo is a rapidly urbanizing coastal city in Western Province, Sri Lanka, faces urban flood risks, particularly during the Southwest monsoon season. Because of these events, we can see disruptions to daily life, infrastructure damage and broader environmental and economic crisis. This paper delves into Rainwater Harvesting (RWH) and sustainable water management strategies as viable solutions to mitigate flood risks in the Negombo urban-coastal zone. A mixed-method approach is adopted, involving hydrological data analysis, case studies and stakeholder interviews to assess current drainage issues and water usage patterns. The study articulates decentralized rainwater harvesting systems and green infrastructure as tools to manage surface runoff and improve water resilience. The findings underscore that integrated water resource planning, when combined with sustainable construction techniques, can significantly reduce the impact of urban flooding. The paper concludes by recommending policy interventions and design strategies that align with climate resilience goals and national sustainable development objectives, with potential applicability to other vulnerable coastal urban areas in Sri Lanka.

Keywords: Climate Resilience; Green Infrastructure; Rainwater Harvesting; Urban Flooding; Water Management; Water Resilience

ICSBE25_181

DEVELOPMENT OF GRAPHENE OXIDE-BASED MEMBRANES FOR WATER PURIFICATION

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Abstract: Water hardness is a significant issue in many countries, including Sri Lanka. Many health issues, such as kidney failure, are affected by the increased levels of Ca^{2+} and Mg^{2+} cations, which can hinder domestic and industrial activities. Graphene oxide (GO) is an efficient nanomaterial for removing such cations due to the presence of carboxylic, hydroxyl, and epoxide groups. However, at the nanoscale, the aggregation of graphene oxide layers reduces its adsorption capacity. The primary objective of this study was to synthesize a Zn^{2+} and imidazole-based Metal-Organic Framework (MOF) and embed it within GO layers to mitigate aggregation. Subsequently, Chitosan (CS) based membranes incorporating the MOF/GO composite were fabricated to adsorb Ca^{2+} and Mg^{2+} ions from water. Membranes with the two ratios of CS/GO (20:1) and (20:3) by weight and three ratios of CS/GO/MOF (20:3:0.3), (20:3:0.6), and (20:3:0.9) were prepared for the study. For the Mg^{2+}, the CS/GO/MOF (20:3:0.6) membrane had the maximum adsorption capacity at 60 minutes, while for the Ca^{2+} adsorption, the CS/GO/MOF (20:3:0.3) membrane had the maximum adsorption capacity at 15 minutes, respectively. Both membranes followed the Langmuir adsorption isotherm model with monolayer adsorption onto the membranes. The maximum monolayer coverage ($Q_{\circ}$) for Mg^{2+} and Ca^{2+} is 19.56 mg/g and 7.41 mg/g, respectively. The adsorption results were promising, as the membranes were able to separate from the water samples easily after the adsorption, and the Ca^{2+} and Mg^{2+} concentrations were reduced to acceptable limits.

Keywords: Adsorption Membranes; Graphene Oxide; Water Hardness; Water Purification

ICSBE25_182

ASSESSMENT OF LANDFILL LEACHATE IMPACT ON WATER QUALITY AND ECOLOGICAL INTEGRITY OF THE MUTHURAJAWELA WETLAND, SRI LANKA: A SPATIAL-TEMPORAL ANALYSIS USING WATER QUALITY AND LEACHATE POLLUTION INDICES

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Abstract: The study investigates the environmental impact of the Kerawalapitiya Waste Park on the Muthurajawela wetland ecosystem, Sri Lanka's largest saline wetland and a sanctuary that covers 1,777 hectares of land. The research used a comprehensive spatial and temporal sampling strategy founded on concentric circle sampling design with five zones from 50 m to 1000 m radii from the waste park centre, totalling 40 sampling points in 13 sites. Monitoring of water quality was conducted for 24 months (2023-2024) via physicochemical parameters, heavy metal analysis, and nutrient analysis. Water Quality Index (WQI) and Leachate Pollution Index (LPI) were used as primary evaluation tools to quantify the extent of contamination and seasonal variation. Results show catastrophic water quality deterioration with WQI values frequently greater than 10,000 during dry seasons, which corresponds to the extreme extent of contamination much beyond the standard measuring scales. The LPI exhibited robust temporal evolution, with much higher values in 2024 compared to 2023 (Dry season: 37.2 vs 19.0; Wet season: 29.0 vs 10.0), reflecting landfill maturation and waste loading influences. Spatial analysis revealed distinct contamination gradients stretching eastwards from the waste park, with the highest impacts concentrated within a 250 m radius. Seasonal variations were pronounced, with dry season concentrations of heavy metals, organic pollutants, and nutrients reaching near critical levels, and dilution in the wet season providing respite. The study validates that landfill leachate is the significant source of contamination of this ecologically sensitive wetland ecosystem, which supports 194 plant species, 40 fish species, and 102 bird species. The combined LPI-WQI assessment framework provides a robust scientific rationale for regulatory intervention and demonstrates the need for integrated waste management initiatives to protect the ecological integrity and biodiversity of the Muthurajawela wetland.

Keywords: Environmental Pollution; LPI; Spatial and Temporal Variations; Wetlands; WQI

ICSBE25_225

DEVELOPMENT OF A PHOTOBIOREACTOR SYSTEM FOR HYDROPONIC RICE CULTIVATION USING OIL STATION WASTEWATER

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Abstract: The current study aimed to develop a multifaceted hydroponic rice cultivation technique using oil station wastewater inoculated with the green micro-alga *Chlorella sp.* (photobioreactor), targeting especially small-scale, export-oriented paddy growers. Rice seeds (BW367) were soaked for 24 hours, sprouted on banana leaf trays, and placed on mud-covered bubble sheets. Seedlings were transplanted into a hydroponic system after 12 days, with seven treatments (tap water (T1), treated wastewater with *Chlorella* (T2), oil station wastewater (T3), mud only (T4), Albert solution (T5), and 100% and 50% oil wastewater with algal inoculum (T6 and T7)) each containing two replicates. Seedlings were examined for six weeks, measuring shoot/root lengths, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), and salinity; paired t-tests and ANOVA analyzed the data. Changes in pH were significant in all treatments except in T2. Statistical analysis showed no significant root growth differences ($p = 0.3879$) but significant shoot growth variation ($p < 0.0001$). Treatments T6 and T7 revealed moderate EC, TDS, and salinity levels, showing that the algal inoculation helped detoxify wastewater while maintaining tolerable ion concentrations for rice seedlings growth. The Δ pH values show the extent of pH change during the experiment, with the highest changes noted in T7 (1.87 and 1.94) and T6 (1.15 and 1.31), indicating strong biochemical activity in oil wastewater combined with algae. Lower variability in shoot length under algal treatments suggests algae make a stable, favourable environment for root and shoot growth. Shoot length increased from 8.8 ± 0.21 to 15.09 ± 0.24 cm in T6 and from 8.73 ± 0.16 to 15.45 ± 0.96 cm in T7, highlighting improved growth with algal inoculation and diluted oil wastewater. Finally, it can be concluded that algal inoculation helps to detoxify oil-containing wastewater while supporting sustainable agriculture.
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Keywords: *Chlorella*; Hydroponic Rice Cultivation; Photobioreactor; Sustainable Agriculture; Wastewater Treatment

ICSBE25_257

NON-REVENUE WATER (NRW) CONTROL STRATEGIES FOR KANDY MUNICIPAL COUNCIL AREA

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Abstract: Non-Revenue Water (NRW) is a critical challenge faced by water utilities worldwide, leading to substantial financial losses, resource wastage and operational inefficiencies. It has been reported that the NRW percentage in Sri Lanka is approximately 25.7%, which is significantly higher than many developed nations (eg. Germany – 8.7%). This project was aimed at estimating NRW in Kandy Municipal Council (KMC) area and formulating technical strategies to reduce it, focusing on Galagedara billing area which falls under Katugasthota region along Galagedara Road. The NRW component in the selected area was quantified using the International Water Association Balance Assessment (IWABA) framework. The data obtained from KMC were analysed using statistical techniques and thematic analysis to quantify NRW in KMC area, identify its primary causes, and evaluate the effectiveness of existing control strategies, with the aim of proposing new approaches for better NRW management. According to the analysis, KMC losses 39.45 % of its treated water as NRW while the loss in Galagedara area is 43.77 %. The main components contributing to NRW in Galagedara billing area were identified as leakages in distribution lines (16.53 %), customer meter inaccuracies (16.19 %) and illegal consumption (7.55 %), all of which result in significant economic loss. In addition, a hydraulic simulation of the distribution network was also to develop recommendations for improving the durability and sustainability of the system. The simulation revealed several vulnerable areas in the distribution network, particularly due to elevated pressure levels and the aging pipeline infrastructure. Therefore, based on the findings, short term recommendations include replacing of water meters which are older than 15 years and establishing an active leakage control system. Long-term strategies include replacing aging infrastructure components and implementing District Meter Areas (DMAs) to enhance monitoring and control.

Keywords: Leakage Detection; Meter Inaccuracies Hydraulic Simulation; Non-Revenue Water; Water Utility

ICSBE25_265

RAINWATER HARVESTING MANAGEMENT IN URBAN INDIA: A CASE STUDY OF SHAHDARA, NEW DELHI

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Abstract: Delhi's escalating water crisis, marked by groundwater depletion and growing demand-supply gaps, necessitates localized solutions. This paper presents a comprehensive Rainwater Harvesting (RWH) management plan for Shahdara, a groundwater-stressed urban ward in East Delhi. The study responds to the urgent need for structured implementation of RWH at the ward level to ensure climate resilience and sustainable urban water management. A mixed-methods approach was employed, including policy mapping, spatial profiling, site visits, and stakeholder consultations, to assess existing regulatory frameworks and identify local enablers and barriers. The proposed plan is structured around three thematic pillars: strengthening institutional capacity through inter-departmental coordination and designated monitoring roles; enhancing public engagement through Information, Education, and Communication (IEC) strategies led by Jal Shakti Kendras; and implementing area-based technical interventions based on local rainfall, topography, and soil data. 29 locations across Shahdara have been identified and suitable RWH techniques, including rooftop systems, recharge pits, swales, and permeable pavements, are recommended accordingly. Performance indicators were also developed to evaluate institutional effectiveness, community participation, and hydrological outcomes. The plan includes a phased roadmap: initiation and budgeting, scoping and data collection, technical planning, execution of RWH structures, and long-term monitoring. The paper demonstrates that hyperlocal, multi-stakeholder RWH planning can significantly improve groundwater recharge, reduce urban flooding, and build community resilience. The Shahdara model is scalable across similar urban neighbourhoods, offering actionable insights for Delhi's broader water sustainability goals.

Keywords: Climate Resilience; Groundwater Recharge; New Delhi; Rainwater Harvesting; Urban Water Management

ICSBE25_360

APPLICATION OF *Lemna minor* (COMMON DUCKWEED) FOR REMOVAL OF MICROPLASTICS FROM WASTEWATER EFFLUENT: A PHYTOREMEDIATION APPROACH

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Abstract: Microplastics (MPs) are an emerging global concern. Wastewater Treatment Plants (WWTPs) are major sources of MPs pollution in aquatic ecosystems. Conventional WWTPs are not specifically designed for MPs removal process and advanced treatments are expensive, often unaffordable for developing countries (e.g, Sri Lanka). This study evaluates the potential of *Lemna minor* (common duckweed) to effectively remove MPs from conventionally treated effluent in a WWTP in Sri Lanka. Effluent samples were collected from a selected WWTP in Galle, Sri Lanka and the initial MPs abundance was analyzed. *L. minor* growth and survival were optimized under effluent conditions. The experiment was conducted to investigate the effects of initial plant coverage (75% and 50%) and exposure time duration (01 to 03 weeks) on MPs removal efficiency from the effluent. According to the results, the recorded initial MP density of effluent was 133.33 ± 26.33 counts/L, highlighting the removal of MPs to the environment even after the conventional treatment. *L. minor* showed strong adaptability in the effluent medium, confirming suitability for phytoremediation. MP removal trend was recorded across all the treatments (74.5% to 39.5%). The key mechanism in MP removal was the adhesion to plant surfaces and fronds. After the first week, the highest removal efficiency was recorded for the 75% of initial plant coverage (74.5%), while 50% coverage had 57.3% ($P < 0.05$). After the third week, removal efficiencies were 71.3% and 72.0% for 50% and 75% treatments, respectively. However, MP removal rate did not significantly increase with the exposure time ($P > 0.05$). In conclusion, 75% plant coverage can effectively reduce MPs within one week, providing a low-cost, sustainable, and scalable strategy for integration into existing WWTP infrastructure by effluent discharge through the phytoremediation of *L. minor*. This approach aligns with the 6th Sustainable Development Goal (SDG 06: Clean Water and Sanitation) by reducing daily MP discharge into the environment.

Keywords: Conventional Wastewater Treatment Plant; *Lemna minor*; Microplastic Density; Phytoremediation; Removal Efficiency

ICSBE25_363

INFLUENCE OF AIR TEMPERATURE, RELATIVE HUMIDITY, AND WIND SPEED ON RAINFALL PATTERNS IN NUWARA ELIYA, SRI LANKA

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Abstract: As the primary centre for Sri Lanka's vegetable and tea production, Nuwara Eliya is a vital agricultural region essential to the country's food security. Recent studies highlight that climate change is already affecting its meteorological conditions. In this socioeconomically significant district, quantifying the relationships between rainfall and key meteorological parameters—particularly air temperature, Relative Humidity (RH), and wind speed—is essential for understanding how climate change influences its complex montane climate. This study addresses this gap by quantifying these relationships through a robust statistical framework. Specifically, Multiple Linear Regression (MLR) and Analysis of Variance (ANOVA) were used to evaluate the impact of these independent variables on rainfall (the dependent variable) across four seasonal phases: the First Inter-monsoon (FIM), Southwest Monsoon (SWM), Second Inter-monsoon (SIM), and Northeast Monsoon (NEM), using 30 years of detrended monthly data (1990–2020). The analysis revealed significant seasonal variability in rainfall drivers. RH was the main contributor (51.5% of explained variance) to the MLR model, with a coefficient of determination (R^2) of 50.3% during FIM. In contrast, during the SWM, the model had an R^2 of 2.5%, suggesting other factors influence rainfall during this period. The model showed an R^2 of 16.5% during the SIM, with wind speed (3.1%) and relative humidity (0.8%) making minor contributions. For NEM, RH explained 28.6% of the variance, and wind speed explained 9.8%, resulting in a model with an R^2 of 36.4%. These findings highlight RH as a dependable predictor, particularly during FIM and NEM periods. This study fills a significant knowledge gap and offers a validated methodological framework for future climate impact assessments in this agriculturally vulnerable area. It also provides a crucial quantitative basis for comprehending the unique rainfall dynamics of Nuwara Eliya.

Keywords: ANOVA; Detrending; Meteorological Parameters; Multiple Linear Regression

ICSBE25_434

ASSESSMENT AND GEOSTATISTICAL MODELING OF GROUNDWATER QUALITY DYNAMICS ASCRIBED TO LAND USE

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Abstract: The rate of dependence on groundwater is high, and groundwater can be identified as an essential freshwater resource in these environments. However, its quality is under threat due to the intensification of current land use activities and the lack of systematic assessment. This study evaluates groundwater quality using 18 wells representing four major land uses (paddy, urban, residential, forest) and examines a suite of 13 key physicochemical parameters, including general water-quality indicators and major ions. Spatial variability analysis was performed using a GIS-based geostatistical modeling (ordinary Kriging) approach with a selected semivariogram model validated using RMSE, ASE, and RMSES. The results reveal that groundwater quality varies significantly with land use within the study area. Degradation of groundwater resources in paddy, urban, and residential land uses is occurring, while forest areas are showing comparatively favorable conditions. When considering the limits of drinking water parameters, 33% of the paddy samples, 58% of urban and residential samples, and 83% of forest samples were within the permissible limits. It shows a clear gradient of degradation closely related to anthropogenic pressures. The results revealed that mainly urban wells reported excess EC, TDS, and alkalinity, reflecting untreated wastewater disposal, land-surface modification, and intensive human activity as direct causes.

Keywords: Dynamics; Geo-statistical Modelling; Groundwater Quality; Kriging; Land Use

ICSBE25_440

ENHANCING OIL ABSORPTION PERFORMANCE THROUGH POLYMER MEMBRANES REINFORCED WITH VERTICALLY ALIGNED CARBON NANOTUBES

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Abstract: One of the major environmental concerns at present is the oil spills in water bodies. Many traditional oil absorbents, including polymer-based membranes, have limited usage due to their deficient selectivity and lower reusability, making them less effective towards oil-water separations. This research was conducted to develop re-engineered polymer membranes incorporating Vertically Aligned Carbon Nanotubes (VCNTs) for enhanced oil absorption. VCNTs were synthesized employing a novel Chemical Vapor Deposition (CVD) approach (single-stage floating catalyst) on a selected ceramic surface using camphor as a carbon source and ferrocene as a catalyst precursor. This approach allows uniform growth and vertical alignment of CNTs on the surface. In order to maintain the alignment of the CNTs in the composite, an unorthodox strategy was employed, as a grown VCNT forest was first saturated with the interested polymer solution (polystyrene(PS) or polydimethylsiloxane(PDMS)). Subsequently, the dried composite film was peeled off the ceramic surface. Fabricated VCNT–PS membranes exhibited around 72% more effective engine oil absorption and 84% increased vegetable oil absorption compared to their pristine polymer membranes; on the other hand, PDMS-VCNT membranes proved to be better absorbents with increased oil absorption and selectivity over water for Petrol, vegetable oil, engine oil, and kerosene. Compared to pristine PDMS membranes, about 130% increased oil absorption and about 33% increased selectivity for petrol were observed by the PDMS-VCNT membrane. Furthermore, the stability of prepared membranes showed positive results in repeated use without significant loss of absorption, displaying enhanced reusability and stability over multiple cycles of absorption and desorption. Overall, this study shows that incorporating vertically aligned CNTs (VACNT) with a suitable polymer can minimize the drawbacks of traditional oil absorption procedures, leading to advanced membrane technologies in oil-water separation applications.

Keywords: CNT-Polymer Composite; CVD; Oil Absorption; VCNTs

ICSBE25_451

COMPARATIVE ANALYSIS OF PUBLIC SPRING WATER QUALITY IN CKDU-ENDEMIC VS NON-ENDEMIC REGIONS OF SRI LANKA

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Abstract: Access to safe drinking water is a critical determinant of public health, yet public springs are rarely monitored. This study aimed to evaluate the water quality of public springs in CKDu-endemic and non-endemic areas of Sri Lanka, relative to national and international standards. Selected water quality parameters of spring water were assessed in Kebithigollawa (8°38'27.2"N, 80°40'10.9"E), a CKDu-affected region, and compared with control springs in Kandy district, a recognized non-endemic area. Ten springs in Kebithigollawa (KebS), including Gonamariyawa, Sinhaya, and Bandra, etc., were analyzed against fifteen control springs in Kandy (KanS). Village-level water use practices were recorded, and spring locations were georeferenced by GPS. Parameters measured included pH, Total Dissolved Solids (TDS), electrical conductivity, fluoride, salinity, and resistivity, benchmarked against World Health Organization (WHO) and Sri Lankan Standards (SLS). Significant differences ($P < 0.05$) were observed between KebS and KanS across several parameters. pH was lower in KebS (mean 6.30 vs. 6.82; $P = 0.023$), suggesting moderately more acidic water possibly linked to geochemical or organic matter influences. TDS was higher (72.44 vs. 55.85 mg/L; $P = 0.035$), indicating more mineral dissolution or surface runoff contributions, while conductivity was elevated (150.00 vs. 113.80 µS/cm; $P = 0.020$), reflecting increased ionic content. In contrast, salinity (172.00 vs. 145.00 µS/cm; $P = 0.168$), fluoride (0.011 vs. 0.0069 mg/L; $P = 0.555$), and resistivity (6.92 vs. 8.29 kΩ·cm; $P = 0.395$) showed no significant differences. 'Minitab-17 Statistical Software' was used for the statistical analysis. Overall, Kebithigollawa springs exhibited pH values below WHO and SLS limits, while all other parameters remained within guidelines. Thus, according to the results, the selected spring water in both areas were generally acceptable for selected parameters. However, continuous monitoring with seasonal variations and integration with existing RO systems would improve safe, reliable access. Future research will extend to microbial and heavy-metal analyses.

Keywords: CKDu; Fluoride; Geochemistry; Salinity; WHO standards

ICSBE25_491

TRENDS OF POLLUTION AND THE CURRENT STATUS OF WATER QUALITY IN MAJOR RIVERS IN SRI LANKA: INFLUENCE OF BEST MANAGEMENT PRACTICES

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Abstract: The rise in urbanization, together with various human activities, has resulted in a remarkable decrease in the water quality of surface water bodies, such as rivers and lakes, over the past few decades. This study aimed to assess the current pollution levels, trends in pollution of rivers in the past decade, and the extent and associated challenges in the implementation of Best Management Practices (BMPs) in major rivers, namely the Mahaweli, Kelani, Nilwala, and Kalu rivers in Sri Lanka. Consequently, water quality data were obtained for the key physio-chemical and biological water quality parameters, namely pH, turbidity, nitrate (NO_3^-), phosphates (PO_4^{3-}), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Hardness (TH), Total Coliform (TC), and Electrical Conductivity (EC) for each river for the period from 2012-2022. Furthermore, a comprehensively designed questionnaire survey was conducted to collect information on the implementation of BMPs in the selected river catchments. The data analysis was conducted by calculating the Water Quality Index (WQI) and using univariate data analysis techniques. It has been noted that coliform is a decisive parameter in deciding the degree of pollution in a water body based on the WQI. Overall, the Nilwala River has been identified as the most polluted river, followed by the Kalu River, whereas the Nilwala River showed a considerable increase in TC levels over the years. However, when considering only the physicochemical parameters, the Kelani River was identified as the most polluted river. Notedly, the trends of pollution of the Mahaweli River and Nilwala River were difficult to identify, except for total coliform. However, the Kelani River and Kalu River showed notable trends in pollution for several key water quality parameters. An increasing trend in nitrate NO_3^- and PO_4^{3-} and a decreasing trend in turbidity, TC over for the Kelani River were noted. On the other hand, the Kalu River showed an increasing trend in pH, turbidity, and BOD, while NO_3^-, PO_4^{3-}, TC, EC, and COD showed a decreasing trend. The outcomes of the study depict that the degree and trends of pollution are entirely dependent on their sources, showing the necessity for pollution mitigation strategies specified to specific catchments. The research also shows that the effectiveness of the design and implementation of BMPs is significantly affected by social, economic, and technical factors.

Keywords: BMPs; Major Rivers; Pollution Assessment; Water Quality

ICSBE25_505

SUSTAINABLE WATER CONSERVATION IN SRI LANKAN INDUSTRIES THROUGH AUTOMATED RAINWATER HARVESTING AND SUPPLY SWITCHING

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Abstract: Water scarcity and increasing utility rates have been a major setback to the industrial institutions in Sri Lanka, particularly those which are water-consuming, such as the apparel-producing industries. To overcome this challenge, this paper introduces the design, implementation and evaluation of an automated switching system, which will enable the utilization of captured rainwater as an alternative supply of municipal water to non-potable uses like toilet flushing. The system developed employs a high-capacity series tank to store the rainwater along with a simple and yet effective monitoring system comprising of conductivity probes to record the water level in each tank, an electronic control circuit to switch the water supply between municipal and rainwater, depending on the level of water in the tank and a few valved fittings that ensure water quality and avoid backflow of the water of one source to another. Once the system was tested with simulated conditions of its operation and supported with the real data of water use, it was concluded that the reduction in municipal consumption of water was 5.5 percent, that gave economical benefits and sustainability. The proposed approach provides for effective, scalable, low-cost and hygienic solutions to industrial water management. In future development, the solution can be augmented to become part of a smart factory system, with the addition of IoT-enabled systems for continual monitoring.

Keywords: Automated Switching; Industrial Water Use; Rainwater Harvesting; Sustainable Systems

ICSBE25_523

INTEGRATED NUTRIENT RECOVERY AND BIOMASS VALORIZATION OF FOOD PROCESSING WASTEWATER BY *Spirulina sp.*

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Abstract: The rapid growth of the global food processing industry has intensified concerns over nutrient-rich wastewater discharges, particularly from fish-processing facilities, which contribute to eutrophication and ecological degradation. This study evaluated the potential of *Spirulina* sp. for integrated wastewater remediation and biomass valorization using untreated effluents from a canned fish processing facility in Beruwala Harbor, Sri Lanka. Cultivation experiments were performed across wastewater dilutions (25–100%) and under varying light intensities (60–240 µmol photons m^{-2} s^{-1}), with BG-11 medium serving as the control. Results revealed that a 75% wastewater dilution provided the optimal balance between nutrient availability and light penetration, achieving a maximum biomass concentration of 0.92 g L^{-1} and removal efficiencies of 83%, 92%, and 90% for COD, nitrate, and phosphate, respectively. Further optimization showed that an irradiance of 180 µmol photons m^{-2} s^{-1} enhanced biomass yield to 1.05 g L^{-1} with nutrient removal exceeding 85%. Comparative analysis demonstrated that this system outperformed previous reports on algal-based wastewater treatment, underscoring the synergistic role of dilution and irradiance in maximizing productivity and remediation efficiency. These findings highlight the dual benefits of *Spirulina* cultivation for resource recovery and environmental protection, advancing a circular bioeconomy model. Future work should address large-scale stability, microbial contamination risks, and techno-economic feasibility to facilitate industrial translation.

Keywords: Biomass Productivity; Circular Bio Economy; Fish Processing Wastewater; Nutrient Recovery; *Spirulina sp.*; Wastewater Remediation

ICSBE25_524

SUSTAINABLE CULTIVATION OF *Spirulina sp.* IN CANTEEN WASTEWATER: OPTIMIZATION OF DILUTION AND LIGHT INTENSITY FOR BIOMASS YIELD

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Abstract: The valorization of nutrient-rich wastewater through microalgal cultivation offers a sustainable alternative to conventional treatment processes, combining pollution mitigation with biomass production. This study investigated the potential of canteen wastewater as a growth medium for *Spirulina sp.*, focusing on the effects of wastewater dilution and light intensity on biomass productivity. Four wastewater dilutions (25%, 50%, 75%, 100%) were compared with BG11 medium, and growth was monitored through optical density (OD_{600}) and dry biomass measurements. The 75% dilution supported the most stable and sustained growth, achieving a maximum OD_{600} of 1.09 and biomass yield of 0.92 g L^{-1} by Day 19, outperforming the BG11 control (0.71 g L^{-1}). In contrast, undiluted wastewater (100%) initially supported strong growth but declined after Day 14, likely due to nutrient toxicity and oxygen stress. Light intensity experiments further revealed that 180 µmol m^{-2} s^{-1} was optimal, producing the highest biomass yield of 1.05 g L^{-1}, while higher irradiance (240 µmol m^{-2} s^{-1}) induced mild photoinhibition and lower light levels restricted productivity. These findings highlight that partially diluted canteen wastewater can effectively replace synthetic media, reducing cultivation costs while supporting high-value metabolite synthesis. The dual benefits of nutrient removal and biomass valorization demonstrate the potential of *Spirulina* systems to advance circular bioeconomy practices in institutional and urban wastewater management. Future studies should address scale-up and continuous operation to bridge laboratory findings with real-world applications.

Keywords: Biomass Yield; Canteen Wastewater Valorization; Optical Density; *Spirulina sp*.; Sustainable Wastewater Treatment

ICSBE25_547

EVALUATING THE PERFORMANCE OF RAINWATER HARVESTING SYSTEMS IN APPAREL MANUFACTURING SECTOR: A CASE STUDY OF TWO CUT AND SEW FACILITIES IN SRI LANKA

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Abstract: Water scarcity is becoming an increasing issue for enterprises around the world, especially in water-intensive industries like apparel manufacture, which are made greater by climate change, urbanization, and population expansion. Apparel factories in Sri Lanka put further strain on the country's already limited resources by relying largely on groundwater and municipal supplies. The efficiency of operations of rooftop rainfall harvesting systems at two cut-and-sew facilities of a well-known apparel manufacturer, Hirdaramani Kuruwita and Hirdaramani Mihila, is assessed in this study. Data from 2024 were analyzed, including rainfall intensity, rooftop catchment potential, tank capacities, harvested water volumes, and facility demand. Key performance indicators, rainwater harvested percentage, net yield, and collection efficiency were calculated to assess utilization against potential. Results revealed substantial underutilization of rainfall, with efficiencies below 10 percent at both sites. At Hirdaramani Kuruwita, despite an annual net yield of 95,557 cubic meters, only 4,311 cubic meters were harvested due to the limited 120 cubic meter tank and partial rooftop connectivity. Efficiency dropped to as low as 1.46 percent during peak rainfall months. At Hirdaramani Mihila, with a larger 120 cubic meter tank, performance improved slightly but still fell to 3.45 percent during October's heavy rains. During dry months, both facilities showed efficiency above 20 percent, indicating the significance of the Rainwater Harvesting System (RWH) as an additional water source for non-production purposes. The results highlight that the main barriers to efficient RWH in the apparel sector are insufficient storage capacity and incomplete rooftop integration. The study suggests increasing storage capacities, integrating all available rooftops, connecting harvested water consumption with seasonal availability, and integrating regular monitoring into sustainability reporting as methods to optimize performance. These actions would improve the industry's sustainability profile, decrease reliance on outside sources, and increase water security.

Keywords: Rainwater Harvesting; Rainfall Intensity; Storage Capacity; Sustainability; Water Scarcity

ICSBE25_659

VARIATION OF WATER QUALITY AND ANTIBIOTIC RESISTANCE GENES IN URBAN RIVERS OF GALLE, SRI LANKA

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Abstract: This research considers about some key water quality and concentrations of Antibiotic Resistance Genes (ARGs) in three urban rivers in Galle: Gin River, Kepu Ela, and Moragoda Ela. pH, Electrical Conductivity (EC), turbidity, Biochemical Oxygen Demand (BOD_5), and level of *E. coli* were measured in 12 sample points (4 sample points from each water source). Next Generation Sequencing (NGS) was used to detect bacterial diversity, showing that Proteobacteria was the highest phylum across all three rivers. The Shannon diversity index indicated a reduction in bacterial diversity downstream in Moragoda Ela, maybe due to pollution. The concentration of ARGs (mphA and blaIMP) was slightly higher in Moragoda Ela, possibly due to human activities.

Keywords: Antibiotic-Resistance Genes; Bacterial Diversity; Galle; Quantification; Urban Rivers

SEISMIC RESILIENCE AND INFRASTRUCTURE SAFETY IN SRI LANKA

ICSBE25_100

ASSESSING URBAN RESILIENCE IN KANDY, SRI LANKA: A MULTI-SOURCE SATELLITE DATA APPROACH TO BUILDING CLASSIFICATION AND LAND DEFORMATION RISK

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Abstract: In Sri Lanka, land deformation poses significant threats to buildings, especially in urban areas where old buildings with low resistance to such threats are prominent. To effectively decide whether buildings should be conserved, reconstructed, or upgraded for improved resistance to threats, this paper highlights the importance of a systematic classification system to evaluate threats posed by urban deformation. An effective evaluation system is required because of the low resistance capacity and sensitivity to earthquakes, such as uplift and subsidence, in Sri Lanka. However, with the aim of improving urban planning and disaster preparedness, this study attempts to design a classification system that can evaluate buildings' vulnerability to urban deformation. The research applied Geographic Information System (GIS) and remote sensing. It focused on assessing the effects of land deformation on buildings in Kandy, Sri Lanka. It created a deformation map using high-resolution Synthetic Aperture Radar (SAR) images, which showed areas affected by subsidence and uplift. At the same time, there was a careful construction of an appropriate building map using Sentinel-2 Multispectral images with a Support Vector Machine (SVM) classification technique. Also, a GIS database was developed to record building features such as age, materials, and construction status. Buildings were sorted based on their vulnerability levels in terms of construction levels and deformation levels by comparing maps. Data from Sentinel-1 Satellite images (SAR) and optical images (Sentinel-2) were also evaluated. The process entailed phase unwrapping, co-registration, and interference generation to produce a map that showed areas where land experienced uplift and subsidence. At the same time, building features such as age and construction status were evaluated using data from Sentinel-2 images. An SVM technique was used for the classification of features on land cover. Values for land deformation taken from images for satellites (S1) datasets in GIS databases permitted improved evaluation for construction features. Buildings with 16.67% showed significant vulnerability, thus immediately required reinforcement and reconstruction. Of all, 50% buildings showed moderate levels required for upgrading and surveillance. At least 33.33% showed low vulnerability with negligible construction. An all-encompassing framework for planning and resource allocation can be provided by this classification system, which is required for responding to emergencies and sustainable urban growth. Planners can model situations, allocate activities, and design for sustainable urban growth with the application of GIS databases improved by deformation information. This model makes it easier for authorities to take anticipatory actions by clearly distinguishing buildings for risk assessment, followed by recommendations for buildings with appropriate technologies and materials that can withstand earth deformations. This particular proposal for improving Sri Lanka's urban resilience stresses the revolutionary character of combining remote sensing and GIS technology.

Keywords: Building Classification; Geographic Information System Database; Geospatial Data Integration; Sentinel 1 SAR; Sentinel 2; Urban Deformation

ICSBE25_268

MODELLING AND ASSESSMENT OF TRAIN-INDUCED GROUND VIBRATIONS: A REVIEW WITH FIELD EVIDENCE FROM SRI LANKA

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Abstract: Train-induced ground vibrations pose a growing concern in densely populated regions, particularly in South Asia, where informal settlements often lie close to railway tracks. This paper examines the generation and propagation mechanisms of such vibrations and evaluates their impacts through field measurements, experimental insights, and predictive modelling strategies. It also provides insights from field measurements of vertical vibration levels recorded at temporary dwellings located near railway lines in Moratuwa and compares these values with the permissible limits specified in national regulations. The study outlines key dynamic excitation mechanisms, ranging from quasi-static loads to high-frequency rail–wheel interactions, and discusses how these vibrations propagate through different wave types in soil. It critically reviews past experimental investigations and categorizes existing prediction models based on the level of complexity in representing vehicle and soil interactions. Three vehicle modelling strategies are examined: (i) constant axle loads, (ii) randomly varying axle loads, and (iii) detailed multibody simulations. For soil modelling, the paper explores 2D and 3D Finite Element Methods (FEM), Boundary Element Methods (BEM), and hybrid approaches. A major focus is placed on boundary conditions in numerical models, emphasizing the importance of infinite and viscous boundaries to minimize wave reflections. Based on the findings, the paper recommends a computationally efficient and physically realistic modelling framework using a 3D finite element model with a multibody vehicle model method and appropriate absorbing boundaries. This approach offers a balanced solution for accurate vibration prediction and can guide infrastructure design and mitigation strategies for conventional and high-speed rail systems in vibration-sensitive environments.

Keywords: Soil Modelling; Train-induced Ground Vibrations; Vehicle Modelling; Vibration Prediction

ICSBE25_428

EFFECT OF TRENCH CHARACTERISTICS ON ATTENUATION OF GROUND VIBRATION INDUCED BY PILLING

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Abstract: Impact pile-induced ground vibration has been identified as a potential source to damage the surrounding structures and discomfort to occupants in nearby buildings. To reduce such damages and discomfort, attenuation of ground vibration becomes an increasingly important need. The most economical solution is the use of open or infilled trenches as wave barriers. This research study investigates attenuation of ground vibration for different trench characteristics: depth, width, infilling materials (Rice husk ash (RHA) and Bottom ash (BA)), and layered infilling materials. A two-dimensional axisymmetric Finite Element Model (FEM) was developed by using Abaqus/CAE software. The model was validated using Peak Particle Velocities (PPVs) obtained through field measurements. The validated model was used for parametric studies. In the analysis of open trenches, a 200 mm wide and 900 mm deep trench exhibited maximum vibration attenuation of 90.3% and 82.4% in the longitudinal and vertical directions, respectively. For the same trench size, BA and RHA reduced ground vibration by 66.2% and 33.3%, respectively, in the longitudinal direction, and by 59.4% and 18.5%, respectively, in the vertical direction.

Keywords: Bottom Ash; FEM; Ground Vibration; In-filled Trenches; Rice Husk Ash

INNOVATIONS AND BEST PRACTICES IN CONSTRUCTION MANAGEMENT

ICSBE25_001

IDENTIFYING THE FACTORS TO SUSTAIN THE ZERO ACCIDENT VISION IN THE CONSTRUCTION INDUSTRY IN THE EASTERN PROVINCE OF SRI LANKA

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Abstract: In the eastern province of Sri Lanka, aiming to achieve a ‘zero accident vision in the construction industry’ is majorly hampered by less safety training, insufficient safety equipment, and less enforcement of safety regulations. Not only in the eastern province of Sri Lanka but also to the whole world, these critical issues not only risk to workers' safety but also targeting directly impact on the project, such as cost and time. This research aims to identify and thoroughly analyse the major key factors avoiding the establishment of a ‘Zero accident environment on Construction sites. A mixed-method approach was utilized with a literature review, as well as conducting interviews and distributing questionnaires to the professionals who were related to the Construction Industry. The collected data was revised and got a statistical analysis to pinpoint crucial trends influential factors. Findings were concluded into the development of a practical framework that highlights the most significant factors affecting safety protocol in construction projects. This framework plays as an essential tool for stakeholders to implement targeted fostering a stronger culture of safety and directly contributing to the realization of a zero-accident vision within the construction sector.

Keywords: Construction Sector; Safety Training; Workers' Safety; Zero Accident Environment Safety Performance; Zero Accident Vision

ICSBE25_028

DESIGN OF A MOVABLE AND FOLDABLE SITE OFFICE WITH EASE OF INSTALLATION AND TRANSPORTATION

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Abstract: This research focuses on designing a mobile, reusable, and easily installable site office to address common issues in traditional site offices made from wood or containers, such as high costs, long setup times, and material waste. The study emphasizes the growing need for flexible and sustainable temporary structures in the construction industry. A literature review highlighted global trends in modular and foldable designs, stressing the value of portability, rapid assembly, and eco-friendly materials. A mixed-methods approach was used, including site visits to thirty construction projects and interviews with industry professionals. The conceptual design was developed using insights from field data, with structural analysis and member design performed using ETABS and Tekla Tedds in line with Eurocode standards. The Multi-Criteria Decision Analysis (MCDA) method was applied to select suitable materials for structural elements, considering strength, durability, sustainability, cost, and aesthetics. The proposed site office size allows two staff members to work comfortably, based on international standards. The proposed movable and reassemblable site office, developed through this research, is highly suitable for practical application in the construction industry, both in Sri Lanka and internationally. Its ease of handling, structural efficiency, cost-effectiveness, and eco-friendly nature make it an ideal solution for modern construction sites. By significantly minimizing project mobilization time and reducing material wastage, this innovative design can contribute meaningfully to enhancing the sustainability and operational efficiency of future construction projects.

Keywords: Mobile Site Office; Modular Construction; Structural Analysis; Temporary Structures

ICSBE25_042

WORKFLOW OPTIMIZATION IN GARMENT MACHINERY SERVICING: AN ECRS-BASED SOLUTION FOR SOP TIME COMPLIANCE

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Abstract: This study investigates productivity improvements in a garment machinery service center by analyzing and reducing time wastages in maintenance processes compared to Standard Operating Procedure (SOP) benchmarks. Through detailed time-motion studies conducted on cover seam machines, we identified three critical operations where mechanics consistently exceeded SOP times: (1) cleaning and levelling machines, (2) dismantling components, and (3) reassembling parts. The primary inefficiencies stemmed from poor workplace organization - mechanics made repeated trips to collect tools, wasted time searching for misplaced disassembled parts, and frequently interrupted work to retrieve missing consumables like oils and greases. To address these issues, we implemented lean manufacturing principles through the ECRS (Eliminate, Combine, Rearrange and Simplify) method and introduced a specially designed service trolley. The trolley, developed using SolidWorks, featured a flat work surface, organized compartments for small parts, dedicated storage for tools and consumables, and magnetic holders for quick access to frequently used items. Post-implementation results demonstrated significant time savings: a 38-minute reduction per service cycle (from 121 to 83 minutes) in key operations, translating to potential annual savings of 18,200 minutes. These efficiency gains enable the service center to complete 65-158 additional machine services annually across different machine types. The solution also improved compliance with 5S methodology, particularly in the "Set in Order" and "Standardize" components. This case study provides garment industry practitioners with a practical, low-cost model for improving maintenance efficiency through workflow analysis and ergonomic interventions, while maintaining strict adherence to SOP time targets. The findings are particularly relevant for garment manufacturers seeking to optimize equipment uptime and maintenance productivity.

Keywords: 5S Workplace Organization; ECRS Method; Garment Machinery Maintenance; Lean Maintenance; SOP Time Optimization

ICSBE25_070

ROLE OF CLOUD BIM ON ENHANCED COST-CONTROLLING TECHNIQUES IN SRI LANKA

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Abstract: The construction industry plays a vital role in a country's economic growth. Besides that, it also faces a number of challenges, such as project delays, cost overruns, time overruns, disputes due to its complexity and stakeholder management, etc. Most of these challenges can be addressed by implementing effective cost control. Even though current practices suffer from time consumption, poor teamwork, inadequate data, and limited real-time access. Building Information Modeling (BIM), especially Cloud BIM, offers a transformative solution with digital representations, collaborative workspaces, and cloud storage, which are widely adopted in developed countries but underutilized in Sri Lanka. Therefore, this research aims to investigate the role of Cloud BIM in enhanced cost-controlling techniques within the construction industry of Sri Lanka. Three objectives have been aligned to achieve the aforementioned aim; they are to determine the available cost-controlling methods, to identify the weakness of the current cost-controlling techniques and to find the available options in Cloud BIM and determine their usability. This study has adopted mixed mixed-methods approach, and construction industry experts are involved with the expert interviews and the questionnaire surveys by sharing their opinions on exploring Cloud BIM's potential in enhancing cost control. Accordingly, the study's findings show that the Cloud BIM significantly improves cost management accuracy and efficiency by providing real-time data access and better stakeholder collaboration. Moreover, integrating Cloud BIM can enhance the productivity, efficiency, and effectiveness of Sri Lanka's construction industry. Furthermore, the study proposes strategic approaches for Cloud BIM adoption, addressing the weaknesses of traditional methods and offering a clear path for the industry to improve project outcomes and financial performance.

Keywords: Cloud BIM; Construction Industry; Cost Controlling; Sri Lanka

ICSBE25_075

SURVIVAL STRATEGIES OF LARGE & MEDIUM-SCALE CONTRACTING FIRMS TO OVERCOME THE IMPACT OF THE ONGOING ECONOMIC DOWNTURN, SRI LANKA

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Abstract: The construction industry is a vital sector that significantly increases Sri Lanka's GDP. Large and medium-sized contractor firms are vital to this sector and frequently perform high-cost initiatives that greatly affect the nation's economy. The economically unstable period has exposed these firms to unpredictable challenges, including widespread financial distress, project suspension, contract cancellation, decreased investments, supply chain issues, shortage of skilled labour, difficulty enhancing resources and even bankruptcies. These challenges threaten not only the viability of the firms themselves but also the broader stability and recovery of the construction industry. Therefore, to overcome those challenges, implementing effective survival strategies showed up as a necessity. This study aims to evaluate and find out the best suitable survival strategies for large and medium-scale contractor firms to sustain in the Sri Lankan construction industry during on ongoing economically challenging period. A comprehensive literature review was conducted to explore the impacts of the economic crises and the associated survival strategies implemented by the global construction contractors. The study employed a mixed-methods approach. Questionnaires were carried out, engaging local construction professionals employed at large and medium firms to examine the ongoing economic downturn's impacts and survival strategies currently being practiced. Also, the study extends to proposes the most effective survival strategies that can be applicable to the local construction context to overcome the economic downturn. Findings reveal that the ongoing economic downturn is having an enormous impact on Sri Lanka's construction industry, and large and medium-sized firms often use a variety of survival strategies. Additionally, this study sheds light on strategies that may not necessarily be effective, even though frequently implemented. The study provided valuable recommendations for large and medium contractors and industry stakeholders seeking to improve resilience and long-term sustainability in Sri Lanka’s construction sector.

Keywords: Economic Downturn; Large and Medium-scale Contracting Firms; Sri Lanka; Survival Strategies

ICSBE25_149

CAUSES OF DISPUTES AND EFFECTIVENESS OF DISPUTE RESOLUTION METHODS: CASE WITH WATER SUPPLY PROJECT

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Abstract: Contractual disputes in water supply projects are more frequent due to uncertainties, complexity and involvement of different stakeholders, etc. If project risk is not properly managed, it will bounce back as disputes, and if those disputes are not resolved promptly, then they tend to escalate project delays, lead to claims, and require dispute resolution proceedings. It may degrade the quality of the work, eventually impact negatively on project constraints associated with cost, time, scope and/or quality. This case study aims to evaluate the causes and impact of contractual disputes and the effectiveness of dispute resolution methods compared with the project constraints. A Design and Build water supply project was taken for this study. Methodology for this study identifies the causes of disputes and evaluates the effectiveness of dispute resolution methods based on dispute settlement rate and their impact on the project constraint diamond. Study reveals that significant causes for the disputes as: vagueness of the contract clauses in the contract documents, pre-contract negotiations and conclusions not properly documented in the Contract Data/Minutes of the Meetings/Conditions of Particular Applications during the formulation of the contract. Most significant causes in post post-contract stage were identified as the employer's financial arrangements, delay in possession of the site, the Project Management Unit's failures in timely and contractually not responding to the contractors' notices of claims. Out of the eighteen major disputes considered for the study, 17% of the disputes were settled through negotiation, no disputes were settled through an engineer's determination and 83% of the disputes were settled through amicable settlement. These dispute resolutions had been compensated by the project constraints, as 36% by time, 34% by cost, 13% by scope and 17% by quality, respectively.

Keywords: Construction Disputes; Dispute Settlement Rate; Project Constraints; Project Risk; Water Supply Projects

ICSBE25_201

THE CHALLENGES FACED BY THE SRI LANKAN CONSTRUCTION CONTRACTORS IN THE BIDDING PHASE

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Abstract: The bidding phase is one of the most crucial stages in any construction project because it determines whether a contractor will secure the work and whether it will be profitable. In Sri Lanka, contractors often face significant challenges at this stage, such as inaccurate cost data, increasing competition, and limited time for bid preparation. These difficulties can lead to incorrect cost estimates, unexpected losses, and reduced competitiveness. This study focuses on identifying the key challenges faced by construction contractors in Sri Lanka when submitting bids and exploring practical ways to mitigate them. A mixed-method approach was employed, combining a questionnaire survey of 100 industry experts with interviews of experienced professionals. The data were analyzed using the Relative Importance Index (RII) method to rank the challenges according to their impact. The study showed that cost data gaps, the risk of overspending, profit loss due to low pricing, and the lack of experienced staff are key challenges affecting contractors. Frequent tender changes, unstable economic conditions, and short production timelines also created significant obstacles. Based on these findings, a digital and data-driven tender risk management framework was developed to help contractors improve cost accuracy, make better decisions, and reduce tender risks. Overall, the study provides valuable insights and practical recommendations to strengthen bidding performance and support the sustainable growth of the Sri Lankan construction industry.

Keywords: Bid-phase Challenges; Construction Bidding; Cost Estimation; Cost Overrun; Profit Erosion; Risk Control

ICSBE25_208

EVALUATING THE EFFECTIVENESS OF TRADITIONAL AND BIM-BASED CONSTRUCTION METHODS FOR MINIMIZING CONSTRUCTION WASTE IN SRI LANKA

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Abstract: Building Information Modeling (BIM) is increasingly recognized worldwide as a modern approach that can transform construction practices, yet in Sri Lanka, its adoption is still at an early stage. This study evaluates how effective BIM-based construction methods are, compared to traditional methods, in reducing material waste and improving overall project performance in the Sri Lankan building construction sector. A mixed-method approach was adopted. First, interviews with experienced professionals helped identify the main causes of waste in traditional projects, such as over-ordering of materials, poor handling on-site, frequent design changes, and the lack of structured waste management. These interviews also highlighted the perceived benefits and challenges of using BIM. Based on these insights, a questionnaire survey was conducted among industry professionals to assess wider opinions and experiences. The findings indicate that BIM is viewed as more efficient than traditional methods, particularly due to its ability to detect errors early, improve collaboration, and optimize the use of resources. However, the study also found that the high cost of implementation and limited awareness remain major barriers to wider BIM adoption. The results emphasize that BIM has the potential to help Sri Lanka significantly reduce waste and achieve sustainability, provided that robust policies, necessary infrastructure, and proper training are put in place.

Keywords: Building Information Modelling (BIM); Improving Project Efficiency; Mixed-Methods Research; Obstacles to BIM Adoption; Reducing Construction Waste; The Specific Context of Sri Lanka; Traditional Construction Methods

ICSBE25_240

INTEGRATING AUGMENTED REALITY AND BUILDING INFORMATION MODELLING TO ENHANCE CONSTRUCTION MONITORING AND QUALITY CONTROL IN SRI LANKA

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Abstract: The integration of Augmented Reality (AR) and Building Information Modelling (BIM) technologies represents a significant advancement in construction management, particularly for real-time monitoring and quality control. However, the adoption of such technologies in developing countries like Sri Lanka remains limited, and a lack of contextual research hinders the realization of their full potential. This study aims to investigate the potential of AR-BIM for enabling real-time construction monitoring and quality control within the Sri Lankan construction industry. A mixed-methods approach was employed, involving a literature review, qualitative expert interviews, and a two-round quantitative questionnaire survey. The findings revealed five significant AR-BIM affordances for the Sri Lankan context: Visualization, Real-Time Monitoring, Interactive Training, Effective Documentation, and Defect Identification. The key barriers impacting these affordances were categorized into human and technological factors. 'User Training and Familiarity' was identified as the most critical human factor, while 'Cost' and 'Hardware Requirements' were the most significant technological impediments. The study concludes that while AR-BIM offers substantial potential to modernize Sri Lanka's construction industry, its successful implementation is contingent on addressing these key challenges. The findings emphasize the need for targeted strategies focusing on professional training, strategic investment to overcome cost barriers, and the development of supportive regulatory frameworks to foster digital adoption.

Keywords: Affordances; Augmented Reality (AR); Building Information Modelling (BIM); Construction Management; Sri Lanka; Technological Adoption

ICSBE25_254

IMPACT OF SUBCONTRACTOR ENGAGEMENT ON MAIN CONTRACTOR'S PERFORMANCE IN BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

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Abstract: The construction industry in Sri Lanka faces significant challenges in project delivery, with 80-90% of construction work subcontracted. Main contractors often struggle to manage subcontractor performance, resulting in project delays, cost overruns, and quality issues that hinder the project's success. This study employed a mixed-methods approach, using structured questionnaires distributed to construction professionals across CS1, CS2, and C1 grade contractors registered in CIDA. A total of 140 responses were collected from site engineers, quantity surveyors, project managers, and supervisors, most with over five years of experience. The Relative Importance Index (RII) method was applied to assess and rank 15 positive impacts, 20 negative impacts, and 15 management recommendations on a five-point Likert scale. Findings reveal that subcontractor engagement enhances project delivery through specialized skills, cost-effectiveness, and improved operational efficiency. However, major challenges include subcontractors' divided attention across multiple projects, unclear contractual terms, and non-compliance with standards, leading to rework and delays. Both domestic and nominated subcontractors were considered of medium to high importance, with domestic subcontractors preferred for cost minimization (47.1%) and nominated subcontractors for quality assurance (34.8%). Key recommendations include rigorous evaluation of subcontractors based on technical expertise and past performance, regular monitoring to ensure quality compliance, clear communication of expectations, and consistent enforcement of safety standards. The study highlights subcontractor engagement as both a strategic advantage and a potential risk. Successful outcomes depend on transparent contracts, effective communication, and continuous performance monitoring. These evidence-based recommendations offer practical strategies for improving project delivery and overall efficiency in building construction projects in Sri Lanka.

Keywords: Main Contractor's Performance; Mixed-Methods Approach; Relative Importance Index (RII); Sri Lankan Building Construction Projects; Subcontractor Engagement

ICSBE25_270

IMPACT OF MATERIAL PRICE FLUCTUATION ON SMALL-SCALE BUILDING CONSTRCUTION COMPANIES IN SRI LANKA DURING THE PERIOD 2020-2022

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Abstract: This study investigates the challenges faced by small-scale building construction companies in Sri Lanka amidst severe material price fluctuations during the 2020 – 2022 economic crisis. Small firms registered under CIDA categories C7 to C9 experienced major cost escalations, particularly in steel and cement, driven by currency depreciation, supply chain disruptions, and government import restrictions. A mixed-method approach incorporating survey data from 97 firms and quantitative analysis was employed to assess the effects on project timelines, workforce stability, and financial viability. The quantitative analysis involved statistical methods such as regression analysis and Monte Carlo simulation to numerically estimate the impact of material price volatility on project delays, cash flow difficulties, and workforce reductions. Results indicate that 78.9% of respondents reported significant material price hikes leading to these outcomes. Adaptation strategies such as material substitution, bulk purchasing, and flexible contract terms were implemented with varying degrees of success. Despite the challenges, 63.6% of firms maintained operations, demonstrating resilience under adverse conditions. The findings highlight the critical vulnerability of small-scale construction firms to economic shocks and underscore the necessity for policy interventions, including support schemes and promotion of locally produced materials, to enhance sector sustainability. This research contributes empirical evidence vital for understanding and addressing material price volatility impacts in emerging economies' construction sectors, offering practical insights for contractors and policymakers to strengthen crisis preparedness and industry resilience.

Keywords: Adaptation Strategies; Construction Industry Resilience; Economic Crisis; Material Price Fluctuations; Small-scale Construction Firms; Sri Lanka

ICSBE25_375

IDENTIFYING FACTORS TO IMPROVE WORKFORCE PRODUCTIVITY IN SRILANKA'S CONSTRUCTION INDUSTRY

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Abstract: The construction industry of Sri Lanka plays a critical role in shaping the country's GDP and infrastructure development. Notwithstanding, the sector has been confronted with low staff productivity, leading to project delays, cost escalation, and inefficient resource use. This quantitative research investigates the main drivers of staff productivity in the Sri Lankan construction industry. A stratified sample of 384 respondents, who were selected from live projects on the basis of roles' variance, was surveyed using a structured questionnaire. The research instrument investigated labour-related, technology, organizational, and management variables using a five-point Likert scale. Data analysis was done using SPSS Version 26 software and for descriptive statistics, reliability testing, correlation, and regression models. The findings indicated that all four dimensions had a significant effect on workforce productivity, with technology as the strongest predictor ($\beta = 0.289$), followed by management ($\beta = 0.273$), labour ($\beta = 0.226$), and organizational conditions ($\beta = 0.194$). The model explained 89.3% of the productivity variance ($R^2 = 0.893$). The findings emphasize the importance of cooperative approaches, leveraging technology adoption in conjunction with quality management and favourable workplace settings. The report recommends that the industry stakeholders invest in digital technologies, leadership skills, and improvements in workers' welfare. Tax relief and vocational training programs are suggested for policymakers to motivate technology adoption and enhance building industry skills.

Keywords: Construction Industry; Management Practices; Sri Lanka; Technology Adoption; Workforce Productivity

ICSBE25_393

IMPACT OF MATERIAL WASTE MANAGEMENT ON CONSTRUCTION COST OF THE PROJECTS IN SRI LANKAN CONSTRUCTION INDUSTRY-COST-BENEFIT ANALYSIS OF WASTE MANAGEMENT IN GREEN BUILDINGS

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Abstract: This study examines a comprehensive cost-benefit analysis of waste management practices in green buildings, using the case study approach to explore the financial, environmental, and social aspects of sustainability. It identifies nine core waste management strategies that are essential to green building operations, including greywater recycling, composting, waste-to-energy conversion, and on-site waste segregation. The analysis outlines both direct costs, such as infrastructure investment, labour, and training, and indirect costs, including administrative expenses and regulatory compliance. At the same time, it evaluates environmental benefits such as reductions in greenhouse gas emissions and decreased reliance on landfills, along with social benefits such as improved employee well-being and stronger stakeholder engagement. This study intended to fill the knowledge gap about the lack of a cost-benefit analysis framework tailored to waste management procedures in green buildings. The created paradigm for cost-benefit analysis shows that sustainable waste management procedures in green buildings have significant long-term economic and environmental benefits, even though they come with a hefty upfront cost. The developed framework provides a structured tool for decision makers to assess the value and viability of waste management strategies in green construction projects. In addition, the study highlights the challenges related to adopting different waste management practices in real, thereby offering practical recommendations that can guide future implementations. By bridging this knowledge gap, the research contributes meaningfully to both academic understanding and professional practice in sustainable building operations.

Keywords: Cost-benefit Analysis; Green Buildings; Sustainability; Waste Management

ICSBE25_445

DETERMINANTS OF BUILDING CONSTRUCTION PROJECT DELAYS: A CASE OF ABOVE C1 GRADE CONSTRUCTION COMPANIES IN WESTERN PROVINCE, SRI LANKA

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Abstract: Delays in construction projects are still a significant problem in Sri Lanka, especially for C1 and above-grade construction companies operating in the Western Province. Project delays reduce stakeholder confidence in the construction sector by causing time frame overruns, cost overruns, and inefficiencies. The study identifies the main causes of project delays and provides solutions. A structured questionnaire was used to collect data from 148 experts, including consultants, engineers, contractors, and project managers. The main causes of delays were identified and ranked using the Relative Importance Index (RII) technique. The investigation found that the most important causes of project delays included labour shortages, material shortages, rework due to contractor errors, subcontractor work delays, and material delivery delays. Industry professionals highlighted the need for stronger qualification requirements for subcontractors, more sophisticated procurement planning, improved quality assurance procedures, better inventory control, and improved labour recruitment and retention. This study presents practical ideas for improving project performance, efficiency, and sustainability, as well as current, specific findings regarding construction delays in Sri Lanka.

Keywords: Construction Project Delays; Procurement Planning; Relative Importance Index (RII); Sri Lanka; Subcontractor Management

ICSBE25_464

DEVELOPMENT OF AN EFFECTIVE MECHANICAL TILE GAP GROUTING METHOD FOR ENHANCED PERFORMANCE OVER TRADITIONAL TECHNIQUES

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Abstract: Tile grouting is a critical process that enhances the structural integrity, water resistance, and aesthetic appeal of tiled surfaces. Traditional manual grouting methods are labor-intensive, time-consuming, and often yield inconsistent quality. To address these limitations, this study developed and evaluated a mechanical tile gap grouting system designed to improve efficiency and performance. A prototype machine was designed and fabricated with adjustable speed control and the capability of grouting multiple lines simultaneously. Comparative experiments were conducted over a 120 ft^2 tiled area to assess grouting time, grout consumption, and finish quality relative to manual grouting. Trials were performed under varying conditions of machine speed and number of grout lines. The results demonstrated a significant reduction in grouting time, ranging from 86.96% to 93.48%, depending on the settings. In addition, grout consumption was reduced by 11%–20% compared to the manual method. Quality of the applied grout was evaluated under three parameters-finish smoothness, crack formation, and tile surface cleanliness through expert feedback. Quality improvement was observed primarily in the test case with low machine speed (0.05 m/s) and a single grout line, achieving approximately 20% grout saving, 87% time saving, and a 7.75% improvement in overall finish quality relative to manual grouting. Although further optimization is required to minimize material wastage and to incorporate mechanisms for edge grouting, the developed system demonstrated considerable potential for both residential and commercial applications. Beyond efficiency, the prototype also offered ergonomic benefits by reducing physical effort and enhancing labour productivity. This research advances the development of mechanized construction tools and demonstrates the practicality of using mechanical systems for tile grouting, while recommending further refinements to improve operational efficiency and quality outcomes.

Keywords: Construction Automation; Finish Quality; Mechanical Grouting Method; Productivity Improvement; Tile Gap Grouting

ICSBE25_564

RELATIONSHIP BETWEEN FEMALE TO MALE RATIO AND PROJECT TEAM EFFECTIVENESS IN SRI LANKAN CONSTRUCTION INDUSTRY

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Abstract: Sustainability demands gender equality, recognizing it as a catalyst for positive impacts across development. Female employees being a minority in the construction industry, where most green inputs are expected, could hinder sustainable development. However, researches reveal that a 30% female-to-male ratio shows the most effective team performance. That ratio for different teams is yet a gap identified in the industry. Quantitative research with a validated questionnaire was carried to identify the relationship between the female to male ratio and project team effectiveness in the construction industry in Sri Lanka. A total population of 112 companies were selected from the road construction sector registered under C1, C2, C3, CS1 and CS2 categories in the Construction Industry Development Authority. 146 respondents were selected randomly from Quantity Surveyors, Project Directors, Project Engineers, Accountants and Design Engineers teams. Optimum performance was noted when the ratio was 28%, 21%, 50%, 66% and 18% for Project Engineers, Project Directors, Quantity Surveyors, Design Engineers and Accountants, respectively. The practitioners could utilize the study results to select work groups effectively for the road construction industry. The study could be expanded to other sectors to verify optimum team performance levels related to the female-to-male ratio.

Keywords: Construction Industry; Female to Male Ratio; Relationships; Team Effectiveness

ICSBE25_658

THE EXTENT OF DELAYS IN INTERIM BILL PAYMENTS FACING CONTRACTORS IN STATE SECTOR CONSTRUCTION CONTRACTS IN SRI LANKA

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Abstract: Payment defaults by the client lead to project disruptions and insolvency of contractors and other parties in the project chain. In this context, the paper examines the extent of interim bill payment delays of Sri Lankan construction contractors engaged in state sector construction contracts in Sri Lanka. In order to determine the extent of interim bill payment delays in construction contracts, the study uses two methods: first, it analyses information provided by two state sector organisations about the interim bills payment delays in construction contracts; second, it examines interim bill payment delay cases referred to adjudication and arbitration involving state sector construction contracts and awards made in those cases. The findings are presented using simple descriptive and interpretive analysis. The study finds that payment delays are common in interim bill payment in state sector construction contracts. Such interim payment delays in the analysed sample are approximately three months and 45% of interim payment delay cases are referred to adjudication. The type of awards\ made in the cases referred to adjudication are as follows: 11% awarded fully, 55% awarded partially:15% rejected, four percent withdrawn and 15% pending. Similarly, 56% of interim payment delay cases have been referred to arbitration. Further, it is noted in most of the payment delay cases filed for arbitration, the awards were in favour of the contractors but made after delays ranging from of 1-6 years. Therefore, a detailed analysis is still needed to develop an integrated system to handle the contract bills by different sections in the state sector to reduce payment delays. Further analysis needs to be done on the adaptability of international practices, such as holding money in a trust account and direct payment to contractors by the Treasury or parent Ministry in Sri Lanka.

Keywords: Construction Industry; Payment Delay; Payment Disputes

ADVANCING SUSTAINABLE CONSTRUCTION: TECHNOLOGIES, MATERIALS, AND PRACTICES FOR A GREENER FUTURE

ICSBE25_127

MULTISCALE COMPUTATIONAL MODELING FOR PREDICTING MECHANICAL BEHAVIOR OF OPC MORTAR

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Abstract: The mechanical behaviour of mortar plays a crucial role in the overall performance of concrete structures. Accurate prediction of its properties is essential for reliable structural design and material optimization. However, many existing numerical models simplify mortar as a two-phase composite or neglect the Interfacial Transition Zone (ITZ) between aggregates and cement paste, which is known to influence fracture behaviour and strength significantly. This study addresses these limitations by enhancing an existing multiscale modelling framework, originally developed for cement paste, to account for the heterogeneous nature of mortar. In the proposed approach, mortar is treated as a three-phase composite, comprising cement paste, fine aggregates, and the ITZ. A Representative Volume Element (RVE) was constructed using MATLAB to reflect realistic mesostructural features, and appropriate material models were assigned to each phase: linear elasticity for aggregates, and the Mazars damage model for both cement paste and the ITZ. The ITZ was assumed to have reduced stiffness and strength compared to the paste, in line with experimental observations. The model was analyzed using COMSOL Multiphysics and validated using experimental compressive strength data for mortar containing 30% aggregate by volume. To evaluate the robustness and predictive capacity of the model, sensitivity analyses were performed by varying ITZ thickness, aggregate size distribution, spatial arrangement, and shape. Results confirmed that incorporating the ITZ significantly improves the model's ability to capture post-peak softening behaviour. The optimal ITZ thickness was found to be 50 µm, and multi-sized aggregates enhanced packing density and stress transfer. Aggregate shape influenced stress concentrations, with circular inclusions yielding more accurate results than elliptical ones. This study highlights the importance of explicitly modelling the ITZ and realistic aggregate characteristics. The developed multiscale model offers a reliable tool for predicting mortar behaviour and can be extended to simulate more complex concrete systems with improved accuracy and efficiency.

Keywords: COMSOL Multiphysics; Interfacial Transition Zone; Mechanical Properties; Mortar RVE; Multiscale Modelling

ICSBE25_178

GEOSPATIAL IDENTIFICATION OF SUITABLE AREAS FOR CONDOMINIUM DEVELOPMENT IN KADUWELA, COLOMBO.

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Abstract: Sri Lanka, Colombo suburbs are undergoing rapid urbanization, and the rising population has created increasing demand within the urban housing sector. Continuous population growth has led to widespread residential expansion without proper alignment with structured land use planning guidelines. As a result, unregulated construction practices have contributed to poorly organized spatial patterns, reduced availability of developable lands, and difficulties in achieving sustainable and well-planned urban growth. This study focuses on identifying suitable areas for condominium development in the Kaduwela Divisional Secretariat Division (DSD) with the combination of geospatial methods (ArcGIS) and Multi-Criteria Decision Analysis (MCDA). The approach targets to support high-density residential development by reducing unregulated urban sprawl and land shortage. Factors were analyzed, such as proximity to services, land value, proximity to road network, land use and land cover, slope, distance to water bodies, and population density. The service accessibility map was created by considering the distance to essential services. An integrated land value map was created by combining the existing land value and the proximity to services map. The Analytic Hierarchy Process (AHP) was utilized to decide the relative importance of each factor affecting land suitability for condominium development. The final land suitability map was created through a weighted overlay analysis. The findings of this study show that 19.49 km^2 (22.14%) of the study area is identified as highly suitable for future condominium development. The area of 24.63 km^2 (27.99%) is identified as suitable, 22.92 km^2 (26.05%) as moderately suitable, 15.98 km^2 (18.16%) as less suitable, and 4.98 km^2 (5.66%) as least suitable for such development projects. This study and methodological framework contributes to sustainable urban development planning by introducing a GIS-based framework for urban planners, real-estate developers, government authorities, and GIS professionals in high-density residential development. The methodology of this study promotes sustainable land use practices without compromising ecological balance.

Keywords: Condominium Development; GIS; Integrated Land Value Assessment; Land Suitability; Multi-Criteria Decision Analysis; Sustainable Urban Planning

ICSBE25_206

DESIGN AND OPTIMIZATION OF LIGHTWEIGHT, HIGH-PERFORMANCE STEEL MODULAR CONSTRUCTION UNITS FOR FLOATING CITIES: A REVIEW OF EXISTING SYSTEMS AND PROPOSAL FOR THE AQUAFRAME SOLUTION

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Abstract: The construction industry faces significant challenges in reducing its environmental impact while addressing the growing demand for sustainable housing solutions. Floating cities, which offer an innovative response to urbanization and rising sea levels, require modular construction systems that are both durable and adaptable to marine environments. However, current systems often fall short in key performance areas such as buoyancy, resistance to saltwater corrosion, and seismic resilience. This research evaluates existing modular construction technologies for floating cities, identifies critical gaps, and proposes a new system designed to meet these challenges. A comprehensive review of modular construction systems was conducted, focusing on advancements in materials like lightweight steel, corrosion-resistant coatings, and Shape Memory Alloy (SMA) bolts. The methodology involved a narrative-synthetic approach, analyzing over 50 high-impact studies from databases including Google Scholar, ScienceDirect, and Scopus. Performance criteria such as thermal efficiency, structural integrity, and environmental resilience were used to assess existing systems and identify technological innovations. The findings reveal that while progress has been made, significant gaps remain in integrating these advancements into a unified modular system for floating cities. This paper introduces the Aquaframe Solution, a new modular construction system that combines lightweight steel units, advanced interlocking mechanisms, and sustainable corrosion-resistant coatings to enhance buoyancy, durability, and energy efficiency. Results suggest that the Aquaframe Solution offers notable improvements in adaptability, cost-effectiveness, and resilience compared to existing systems. This research contributes to the development of scalable and sustainable floating city solutions, with future work focusing on optimizing material durability, improving environmental integration, and enhancing modular system scalability to meet the complex needs of floating city construction.

Keywords: Aquaframe Solution; Corrosion Resistance; Floating Cities; Marine Environments; Modular Construction; Steel-based Systems; Sustainability

ICSBE25_213

SPATIOTEMPORAL DYNAMICS OF RIVERBANK EROSION AND ACCRETION IN RESPONSE TO HUMAN ACTIVITIES IN THE LOWER MAHAWELI BASIN

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Abstract: Soil erosion is widely recognized as one of the most destructive forms of land degradation, with severe consequences for the hydrosphere, increased vulnerability to natural hazards, and declining agricultural productivity. Effective management of this phenomenon is particularly critical within watershed areas. This study focuses on the lower Mahaweli Basin in the Trincomalee District of Sri Lanka, a region that has exhibited growing susceptibility to soil erosion in recent years. The study was conducted with the primary objective of analyzing the spatiotemporal variation of riverbank erosion and accretion in this area over the period 2000 to 2023. The intensification of anthropogenic activities, particularly river sand mining, has emerged as a key driver of riverbank degradation. The utilization of remote sensing and Geographic Information Systems (GIS) supported by the Modified Normalized Difference Water Index (MNDWI), enabled consistent and accurate monitoring of river morphology across the study period. Riverbank erosion and accretion were quantified separately by extracting river shapefiles for each time step. Results indicate a clear increasing trend in riverbank erosion from 2000 to 2020, peaking at an erosion rate of 46.93% in 2020. In contrast, the period from 2020 to 2023 demonstrated a reversal of this trend, with a maximum accretion rate of 57.82% recorded in 2023. The surge in erosion observed up to 2020 corresponded with areas subjected to intensive sand mining, while the subsequent increase in accretion was predominantly observed in the northern coastal zone, especially within the Kinniya Division. These findings offer valuable baseline information for policymakers and resource managers, supporting evidence-based decision-making aimed at sustainable watershed management and erosion mitigation in the lower Mahaweli Basin.

Keywords: ArcGIS; Land Degradation; MNDWI; Remote Sensing; Sand Mining

ICSBE25_232

INTEGRATION OF MACHINE LEARNING TECHNIQUES TO PREDICT THE BOND PERFORMANCE OF CFRP/CONCRETE

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Abstract: This study examines the applicability of Machine Learning (ML) techniques in predicting the bond performance of Carbon Fibre Reinforced Polymer (CFRP) and concrete. Traditional prediction methods include finite element modelling and numerical predictions, which require higher computational power or oversimplify the actual behaviour. To address these limitations, a database of over 800 single-lap shear tests was collected and used to train and validate various ML models, which were selected considering the scenario of prediction and the viability of data, which includes K-Nearest Neighbours (KNN), Support Vector Machines (SVM), Artificial Neural Networks (ANN), Multilayer Perceptron (MLP), TabNet, and ensemble models like LightGBM, CatBoost, and XGBoost. Among these, the XGBoost model achieved the highest accuracy, as indicated by the coefficient of determination and mean squared error. Also, in this research to find the importance of the input variables used in the model, the XGBoost model achieved excellent accuracy (R^2 = 0.9893). To further understand the mechanism and predictability in these bonds, SHAP (Shapley Additive exPlanations) analysis was employed. By SHAP, we found out that bond thickness and width of the CFRP strip are the most important input variables in our compiled dataset. This research demonstrates ML's potential to transform structural engineering by delivering highly accurate and interpretable predictions of CFRP-concrete bond behaviour.

Keywords: Bond Performance; CFRP/Concrete Bond; Machine Learning; SHAP; Single-lap Shear

ICSBE25_235

DURABILITY-BASED LIFE CYCLE ASSESSMENT TO INVESTIGATE SUPPLEMENTARY CEMENTITIOUS MATERIALS

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Abstract: Partially replacing the Ordinary Portland cement (OPC) with Supplementary Cementitious Materials (SCMs) has a huge trend in sustainable construction. This study examines the environmental, durability, compressive strength and economic impacts of concrete containing Rice Husk Ash (RHA) and Sugarcane Bagasse Ash (SCBA), incorporating a durability-based Life Cycle Assessment (LCA) framework. These agricultural by-products have a higher silica content, making them highly reactive pozzolanic materials. This methodology evaluates the long-term performance of RHA and SCBA mixed concrete, using a cradle-to-grave LCA approach and integrating durability results to assess the influence of SCMs on concrete degradation mechanisms. This involves service life prediction using Life-365, data gathering from case studies and life cycle impact assessment using SimaPro software and combining these with compressive strength results and Rapid Chloride Penetration Test (RCPT) results as a durability indicator. Five concrete mixes, which contained 100% OPC, cement replaced mixes at 15% and 30% with RHA and at 5% and 25% with SCBA, were used for the study. The LCA study measured the key environmental indicators such as Global Warming Potential (GWP), ozone formation and resource depletion. Service life modelled using Life-365 showed that concrete containing RHA and SCBA have a longer durable service life compared to OPC concrete, which is resulted due to reduced permeability according to the RCPT results when SCMs were used. The findings highlighted the potential of SCMs to reduce carbon footprint and enhance concrete durability, contributing to more sustainable infrastructure. This study reinforces the role of SCMs in promoting circular economy principles within the construction industry while addressing environmental concerns. The results provide valuable insights for engineers, policymakers, and researchers aiming to balance sustainability and performance in cementitious materials in the construction industry.

Keywords: Durability; Global Warming Potential (GWP); Life Cycle Assessment (LCA); Ordinary Portland Cement (OPC); Supplementary Cementitious Materials (SCM)

ICSBE25_286

PERFORMANCE OPTIMIZATION OF SILICA FUME MODIFIED EPS LIGHTWEIGHT CONCRETE FOR SUSTAINABLE CONSTRUCTION

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Abstract: This study investigates the development of lightweight, high-performance concrete by incorporating Expanded Polystyrene (EPS) as a coarse aggregate replacement, alongside silica fume as a supplementary cementitious material. The objective is to enhance the structural viability of EPS-concrete, traditionally limited to non-load-bearing applications, by optimizing mix design and evaluating mechanical and durability properties. Grout samples were prepared using Ordinary Portland Cement (OPC) and Blended Hydraulic Cement (BHC), with silica fume dosages of 0%, 3%, and 6%, and subjected to different curing regimes. Results identified 3% silica fume under wet curing as the optimal combination for strength enhancement. This optimized grout mix was then applied to EPS-concrete specimens, which exhibited significant improvements in compressive strength, reaching 7.07 MPa at 28 days. Water absorption tests demonstrated reduced permeability compared to conventional concrete, owing to the non-absorbent nature of EPS and the filler effect of silica fume. The findings indicate that EPS-concrete, when modified with silica fume and properly cured, offers a viable, eco-friendly alternative for structural applications, aligning with sustainable construction goals.

Keywords: Compressive Strength; Curing Regimes; EPS Concrete; Lightweight Concrete; Silica Fume; Sustainable Materials

ICSBE25_307

A REVIEW ON THE ROLE OF GRAPHENE OXIDE IN ENHANCING THE DURABILITY AND SUSTAINABILITY OF CLAY-BASED PRODUCTS

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Abstract: The clay industry in Sri Lanka faces critical challenges, including low durability of finished products, high susceptibility to cracking during drying and firing, substantial shrinkage, and significant material wastage. Traditional clay-based products exhibit low compressive strength (2.8-15 N/mm^2), excessive water absorption rates (15-18%), and poor thermal stability, limiting their application in modern construction and compromising their sustainability. These limitations necessitate innovative approaches to enhance the mechanical properties and environmental performance of clay-based materials while maintaining their cultural and economic significance. This review examines the integration of nanomaterials, particularly Graphene Oxide (GO), into clay-based products to address these inherent deficiencies. A comprehensive analysis of recent literature was conducted to evaluate the types and characteristics of Sri Lankan clay, assess traditional and modern processing methods, and investigate the impact of GO incorporation on mechanical and durability properties. The review specifically focuses on how GO's exceptional characteristics, including high surface area exceeding 2600 m^2/g, abundant oxygen-containing functional groups, and strong bonding capabilities, enable effective interaction with clay particles at the nanoscale. The findings reveal that optimal GO concentrations (0.02-0.3% by weight) significantly enhance compressive strength by 15-54% and reduce water absorption by up to 40%. GO incorporation improves microstructural organization, increases fracture toughness, enhances thermal stability, and extends product service life. These improvements address critical performance limitations while supporting sustainable manufacturing practices through reduced material consumption and enhanced durability. This review demonstrates that GO-enhanced clay products offer substantial potential for modernizing Sri Lanka's traditional clay industry, improving competitiveness in international markets, and preserving cultural heritage. The integration of nanotechnology with traditional craftsmanship presents a pathway toward sustainable, high-performance clay-based materials that meet contemporary construction demands while maintaining economic viability.

Keywords: Clay; Durability; Graphene Oxide; Mechanical Properties ; Nanomaterials

ICSBE25_323

GEL POLYMER ELECTROLYTES SUITABLE FOR ENERGY STORAGE USING HIGHER VOLTAGES

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Abstract: Gel Polymer Electrolytes (GPE) have gained significant interest in the energy sector for their chemical/mechanical stability, addressing critical limitations of liquid electrolytes, including leakage, flammability, toxicity and poor dendrite suppression. GPE is a class of Polymer Electrolyte (PE), also known as plasticized PE. Herein, a series of GPEs were prepared by solvent casting, incorporating Lithium Trifluoromethanesulfonate/ LiOTf salt (5-20 wt% relative to polymer weight) into a PEO: PEG (1:1 wt. ratio) polymer matrix plasticized with Ethylene Carbonate (EC): Propylene Carbonate (PC) (8:9.3 ratio). The four electrolytes labelled (according to the LiOTf wt%) as 5%LiOTf, 10%LiOTf, 15%LiOTf and 20%LiOTf were prepared. Electrochemical impedance spectroscopy revealed that conductivity increases with salt concentration, giving 0.35, 0.81, 1.07 and 1.50 mS cm^{-1} for 5%, 10%, 15% and 20% LiOTf, respectively, at 20 °C. The higher salt concentrations give the conductivity levels required for many applications, reaching above 1 mS cm^{-1}. The temperature dependence of ionic conductivity showed Vogel-Tammann-Fulcher (VTF) behaviour for all formulations in the range of 20°C -80 °C. Chronoamperometry showed ionic transference numbers greater than 0.99 for all electrolytes, confirming that ions predominantly mediate charge transport. The 20%LiOTf GPE shows a broader 4 V stability window, confirming its suitability at higher voltages. Supercapacitors made incorporating 20%LiOTf gave gravimetric energy densities and power densities of 8.1, 7.77 and 6.21 Wh kg^{-1}; 1190.69, 1657.11 and 3901.57 W kg^{-1}, respectively, at current densities, 0.8, 1.6 and 3.1 mA cm^{-2}. The absence of peaks related to Faradaic reactions in CV curves confirms electrolyte inertness and electrical double layer behaviour within the operational voltage window. The results demonstrate the potential of using the GPE for energy storage using higher voltages than aqueous electrolytes based. PEO's electrochemical stability and salt solvation support flexible, high-voltage supercapacitors. GPEs provide good electrode wetting, thermal/mechanical stability, and uniform Li^+ distribution that prevents dendrite growth. While less conductive than liquids, GPEs offer superior safety and a higher operational voltage window. This work suggests potential structure-property relationships for developing scalable, sustainable energy storage applications.

Keywords: Energy Storage Devices; Gel Polymer Electrolytes; Ion -conductive Polymer Blend; Lithium Trifluoromethanesulfonate; Sustainability

ICSBE25_329

ENDPOINT-BASED LIFE CYCLE ASSESSMENT OF GREEN VERSUS CONVENTIONAL BUILDINGS IN SRI LANKA

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Abstract: Green buildings are promoted as a solution to the construction sector's environmental footprint, yet few studies comprehensively compare their impacts with conventional buildings across complete life cycles. This study applies a cradle-to-grave endpoint cycle assessment (LCA) to evaluate a certified green university building in Sri Lanka against a conventional baseline. Using the ReCiPe method in SimaPro, environmental burdens were quantified per square meter of gross floor area, covering material extraction, transportation, construction, operation, and end-of-life stages. Results show that green buildings achieve significant reductions in endpoint impacts: human health damages (0.0085 vs. 0.0058 DALY), ecosystem loss (0.000018 vs. 0.000012 species·yr), and resource depletion (222.83 vs. 152.77 USD2013). Operational savings dominate these reductions, with global warming potential decreasing by over 40% and freshwater eutrophication halved. Material extraction remains a persistent hotspot due to intensive use of steel and aluminium, while the end-of-life stage offers further benefits through improved recovery and reduced reliance on landfill. By extending analysis beyond mid-points to endpoint consequences, this research highlights how green building strategies translate into tangible improvements for human health, biodiversity, and long-term resource availability. The findings fill a gap in Sri Lanka's limited LCA research base and provide evidence for policymakers and practitioners seeking strategies to lower environmental burdens in the building sector.

Keywords: Cradle-to-grave; Endpoint Impacts; Green Buildings; Life -cycle Assessment; Sustainable Construction

ICSBE25_334

MAPPING THE DYNAMICS OF WIND: GIS BASED SITE SUITABILITY FOR WIND FARMS IN SRI LANKA

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Abstract: Wind energy is a key component of sustainable development, but careful site selection is essential to maximize energy generation while minimizing environmental and social impacts. This study focuses on identifying suitable locations for onshore wind farms in Sri Lanka using a GIS-based multi-criteria analysis. DEM raster data from USGS Earth Explorer, wind speed data from the Global Wind Atlas, land cover data from Esri World Land Cover, and protected area boundaries from Google Earth Pro were used as input layers. The analysis was conducted in ArcGIS Pro using tools such as Slope, Reclassify, Raster Calculator, and Weighted Overlay. According to the weighted overlay method, the criteria were assigned the following weights, which were generated using AI: wind speed (50%), slope/elevation (20%), protected areas (20%), and land cover (10%). The criteria layers were combined to generate a final suitability map under three categories: higher (66-100), medium (33-66), and unsuitable (0-33), where higher values indicated more suitable areas for wind farm development. The analysis highlights locations with high wind potential, including Kandakuli, Puttalam, Mannar, Poonkary, Chavakachcheri, Vanai, Yakkala, and Wellawaya, characterized by gentle terrain, minimal environmental restrictions, and compatible land use. The already available wind farms, such as the Hambanthota wind farm and Nirmala wind farm, located in the areas highlighted by the red color, proved the accuracy of the suitability map. The resulting suitability map provides a practical framework for strategic planning of wind energy infrastructure, supporting sustainable development while minimizing ecological and social impacts.

Keywords: GIS; Sustainable Development; Weighted Overlay; Wind Energy

ICSBE25_350

EFFICIENCY ASSESSMENT OF LIGHT PIPE TECHNOLOGY FOR ENERGY CONSERVATION IN TROPICAL CLIMATES: A SUSTAINABLE LIGHTING APPROACH

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Abstract: Energy use for lighting makes up about 20% of global electricity consumption and 6% of global CO_2 emissions. Projections suggest a 60% rise by 2030. This study looks at how effective light pipe technology is as an alternative to artificial lighting systems for saving energy in tropical climates. The research compared traditional LED lighting and light pipe systems for a 1,000 square foot basement area in a two-story building. The calculations showed that standard LED lighting uses 138.24 kWh each month (32 bulbs at 12 W each). In contrast, a proposed light pipe with a diameter of 0.58 m and a length of 6 m could save 104.832 kWh each month. A 1:250 scale model was built with polycarbonate pipes and optical lenses to test the idea. The results showed that light pipe technology can lower energy use compared to artificial lighting systems. However, the high upfront installation costs are a major barrier to widespread use in homes. The study concludes that while light pipe technology can save a lot of energy, changes in policy and strategies to reduce costs are needed for it to be practical in developing countries with tropical climates.

Keywords: Applications in Tropical Climate; Daylight Harvesting; Energy Conservation; Light Pipe Technology; Sustainable Lighting

ICSBE25_364

INCREMENTAL HOUSING, SPATIAL TRANSFORMATION, AND COMMUNITY RESILIENCE: LESSONS FROM TORRINGTON HATEWATTA, COLOMBO

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Abstract: Informal settlements in South Asian cities reflect both the vulnerabilities and the adaptive strengths of low-income urban communities. This study explores how incremental housing practices and community-led spatial transformations contribute to resilience and long-term sustainability in such environments. The Torrington Hatewatta settlement in Colombo, Sri Lanka, is examined as the case study. Using field observations, cognitive mapping, and household interviews, the research traces how homes have evolved across generations, from simple timber structures to multi-storey concrete dwellings that increasingly include rental units. Alongside these changes, streets and open spaces have been reshaped into multifunctional communal areas that support daily social and economic life. The findings reveal a gradual shift where public and semi-public spaces are absorbed into private domains, creating new layers of micro-public and micro-private spaces. These shifts have reconfigured the settlement's spatial fabric, resulting in narrower roads, fragmented circulation networks, and heightened neighbourhood density. While these changes increase privacy at the household level, they also intensify congestion across the community. In the absence of consistent state support, local welfare societies play a critical role in strengthening collective resilience and social cohesion. The paper argues that the incremental evolution of Torrington Hatewatta provides important insights for housing policy. Community-driven, low-cost, and adaptive approaches offer a more socially grounded alternative to state-led high-rise relocation programmes, which often disrupt residents' identities, autonomy, and social networks. The case highlights the potential of incremental housing models to inform more sustainable and culturally rooted construction strategies in rapidly urbanising contexts.

Keywords: Community Resilience; Incremental Housing; Informal Settlements; Spatial Transformation; Sustainable Construction; Urban Policy

ICSBE25_385

ECO-FRIENDLY PRINTABLE CONCRETE FORMULATION USING RECYCLED HDPE PLASTIC WASTE AS A PARTIAL REPLACEMENT FOR NATURAL AGGREGATES

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Abstract: The use of recycled plastic waste in concrete provides an effective means of minimizing environmental pollution while conserving natural aggregate resources. This research focuses on the performance of 3D printable concrete incorporating High-Density Polyethylene (HDPE) waste plastic as a partial replacement for Natural Coarse Aggregates (NCA). A conventional 3D printable concrete mix design was modified by replacing 20% of cement with fly ash to enhance sustainability. Based on this mix, concrete samples were prepared with 0%, 10%, 30%, and 100% volumetric replacement of NCA by crushed HDPE aggregate, maintaining a constant water-to-cement ratio of 0.32. Fresh properties were assessed through mini slump and flow table tests, which confirmed acceptable workability and flowability for 3D printing applications. Workability was further enhanced using a high-range water-reducing superplasticizer (Plastobuild ES). Mechanical performance was evaluated via compressive strength tests on 150 mm cubes at 1, 7, and 21 days. The 30% HDPE mix demonstrated a favourable balance between strength (reduction from 52.53 MPa to 36.06 MPa), printability (increase in flow diameter from 146 mm to 160 mm), and environmental performance, including reduced carbon emissions when compared with 0% HDPE mix. And also, the stress–strain behaviour was studied using strain gauges to monitor deformation characteristics. Overall, the study demonstrates that recycled HDPE can successfully serve as a partial substitute for aggregate in 3D printable concrete, supporting sustainable construction practices while slightly compromising essential mechanical and rheological properties.

Keywords: 3D Printable Concrete; HDPE Plastic; Natural Aggregate Replacement; Sustainable Construction

ICSBE25_414

FORMULATING A CUSTOMER VALUE PROPOSITION FOR FLY ASH- BRICKS AND BLOCKS THROUGH VALUE QUANTIFICATION APPROACH

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Abstract: The process by which consumers make product purchase decisions extends beyond the mere fulfilment of primary and anticipatory needs. Empirical evidence suggests that product price is often the principal determinant guiding these decisions. Consequently, the task of price-setting by manufacturers is both fundamental and intricate, as inadequate pricing may erode profit margins or inadvertently devalue the product, while excessive pricing can suppress demand. Scholarly literature delineates "price" as comprising three distinct components: (i) objective price, (ii) perceived nonmonetary price, and (iii) sacrifice. Within the marketing domain, price-setting methodologies are broadly categorized into three principal approaches: cost-based pricing, competition-based pricing, and value-based pricing (alternatively termed customer-based or customer value-based pricing). Furthermore, research reveals that "value word equations", "value case histories", and "value calculators" constitute essential tools employed by leading manufacturers to articulate and substantiate the added value inherent in their offerings. Despite variation in precise definitions, the primary objective underlying these tools is to underscore the tangible benefits conferred by the product. Nonetheless, firms often encounter significant challenges in identifying the optimal configuration of parameters that will most effectively address customer expectations and maximize satisfaction. This research proposes a conceptual framework aimed at elucidating the parameter combinations that constitute a compelling customer value proposition, thereby influencing purchase intent. As an applied example, the research employs the case of fly ash bricks and blocks, wherein a "value quantification" exercise is conducted. This quantification process encompasses five quantitative parameters and one qualitative parameter, analysed through a case study approach. The investigation culminates in the presentation of a comprehensive methodology designed to determine the "customer desired value" or "net value"—a practical and actionable roadmap for manufacturers and research and development organizations seeking to translate the abstract concept of customer value into concrete, implementable strategies.

Keywords: Customer Value Proposition; Fly Ash Bricks and Blocks; Pricing Strategies; Purchase Decisions; Value Quantification

ICSBE25_419

MACHINE LEARNING BASED VIBRATION PREDICTION FOR SAFETY MONITORING IN CONSTRUCTION SITES

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Abstract: Impact pile driving generates ground vibration that causes discomfort to neighbouring occupants and damages to nearby structures and sensitive equipment, highlighting the vibration monitoring during pile driving is an imperative need. Despite advancements in technologies, vibration monitoring is practiced manually, which is not always practical and efficient due to the dynamic nature in the construction site environment. The objective of this study is to integrate Machine Learning (ML) techniques for the prediction of ground vibration propagation. Methodology consists of construction site selection, Finite Element (FE) model development and validation, vibration data extraction, ML model training and performance evaluation. Potential of Artificial Neural Network (ANN), Extreme Gradient Boosting (XGB), Random Forest (RF) and Decision Tree (DT) as ML tools was studied. Among the ML models, XGB demonstrated the best predictive performance, with an R^2 of 0.86, an RMSE of 0.46 mm/s, and an MAE of 0.21 mm/s, whereas the ANN model showed a comparatively lower performance, with an RMSE of 0.54 mm/s. Results enable managers and safety officials to monitor ground vibration and exposure to implement safety measures.

Keywords: Construction Vibration; Machine Learning; Pile Driving; Vibration Prediction; Vibration Safety

ICSBE25_423

PROPERTIES OF CEMENT MORTAR WITH EGGSHELL POWDER AND FLY ASH

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Abstract: With the rapid growth of the population, increasing infrastructure demand leads to higher cement production and significant CO_2 emissions. Using waste materials as a partial replacement of cement while keeping cementitious properties is a reasonable solution to prevent the significant environmental issues caused. This research investigated strength and durability properties, cost effectiveness, and energy efficiency of cement mortar developed with Fly Ash (FA) and Untreated Egg Shell Powder (UESP) as cement replacements. Mortar cement: 1: 2.25 (weight) sand was cast. Experimental tests were done on strength and durability performance. Numerical assessment of life cycle and cost assessments was carried out. Greenhouse gas emission, embodied energy, and cost are lower in the untreated eggshell powder-added mixture with acceptable strength and durability properties.

Keywords: Engineering Properties; Life Cycle Analysis; Mortar; Supplementary Cementitious Materials; Sustainable

ICSBE25_425

UTILIZATION OF RECYCLED READY-MIXED CONCRETE WASTE AS FINE AGGREGATES IN SUSTAINABLE CONSTRUCTION

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Abstract: The increasing scarcity of natural river sand and the growing accumulation of concrete waste from Ready-Mixed Concrete (RMC) plants have driven the search for sustainable alternatives in the construction industry. This study investigates the potential of Recycled Ready-Mixed Concrete Waste (RRCW) fines as a partial replacement for river sand in concrete production. The RRCW fines were obtained from dried, crushed, and sieved sedimented cement grout waste collected from the sedimentation tanks of RMC plants. A comprehensive experimental program was conducted to evaluate the physical properties of RRCW fines and assess their influence on the workability and compressive strength of concrete. Concrete mixes were prepared with RRCW fines replacing river sand at 0%, 10%, 20%, 30%, 40%, and 50% levels by weight. Material tests revealed that RRCW fines have acceptable grading and specific gravity but slightly higher water absorption and microfine content (4.22%) than typical fine aggregates. Slump test results showed a gradual reduction in workability with increasing RRCW content, primarily due to the angular shape and high absorption capacity of the fines. Despite the reduction, all slump values remained within the medium workability range. Compressive strength testing showed an increase in strength up to 10% replacement (28.31 MPa), with strength values still comparable to the control mix (25.46 MPa) at 20% and 30% replacement levels. However, strength declined beyond 30%, reaching 20.80 MPa at 50% replacement. The findings suggest that RRCW fines can be effectively used up to 30% replacement without compromising concrete performance, making them a promising sustainable alternative to river sand. The use of this alternative fine aggregate not only focuses on effective waste management, but also supports environmentally responsible construction practices.

Keywords: Ready-mixed Concrete Waste; Recycled Concrete Aggregates; Recycled Concrete Fines; Sustainable Construction Materials

ICSBE25_426

POTENTIAL OF RECYCLED CONCRETE AGGREGATE (RCA) MODIFIED WITH CEMENT SLURRY COATING TECHNIQUE FOR MANUFACTURING CONCRETE PAVING BLOCKS.

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Abstract: Concrete aggregates are accumulating in construction sites without having a specified usage. This study investigates the potential of Recycled Concrete Aggregate (RCA) modified with a cement slurry coating technique to replace coarse aggregates in manufacturing concrete paving blocks. The modified RCA was prepared with a water-to-cement ratio of 0.4, and its properties were compared with Natural Aggregates (NA). Paving blocks of M25, were produced with partial replacement of NA by modified RCA at 0%, 10%, 20%, and 30% (by weight). Properties of modified RCA and paving blocks manufactured with modified RCA were examined in laboratory experiments. Results showed that the Aggregate Impact Value (AIV) of natural aggregates and modified RCA were 11.07% and 14.49%, respectively. At all replacement levels, the 7-day compressive strength and 28-day compressive strength satisfied the required limits recommended in standards. These findings demonstrate the potential of cement slurry coating to modify the RCA, which can be used in paving blocks manufacturing.

Keywords: Aggregate Impact Value; Cement Slurry; Concrete Paving Blocks; Recycle Concrete Aggregate

ICSBE25_431

MECHANICAL PROPERTIES OF GRAPHENE OXIDE (GO)-TREATED TEXTILE FIBERS INCORPORATED CEMENT MORTAR

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Abstract: With the growth of the global population, textile waste is rapidly increasing, and its non-biodegradable components and limited recycling options create major environmental challenges. Reusing these textiles as fibers to make construction materials is one of the possible solutions to this problem. This research investigates the incorporation of Graphene Oxide (GO)-treated textile fibers (cotton and polyester) into cement mortar to enhance its mechanical properties. Mortar with a cement: sand ratio of 1:2.25 (by weight) was prepared with varying percentages of polyester and cotton fibers. The addition of fibers was found to reduce workability, though values remained within the acceptable flow range. Flexural strength was increased by 20% with the addition of 0.1% polyester and 0.15% cotton, and by 12% with the addition of 0.1% cotton and 0.15% polyester, compared to the conventional mortar, indicating the potential of treated textile fibers to enhance flexural properties. Compared to the conventional mortar, the mortar with 0.1% cotton and 0.25% polyester showed a 0.5% reduction in weight, while the mortar with 0.1% polyester and 0.25% cotton showed a 0.4% reduction. Compressive strength was increased by 20% in the mortar containing 0.1% polyester and 0.25% cotton, and by 11% in the mortar with 0.1% cotton and 0.25% polyester, compared to the conventional mortar.

Keywords: Cement Mortar; Cotton; Fiber-reinforced Cement Mortar; Graphene Oxide; Polyester

ICSBE25_439

DESIGN OF A LIGHTWEIGHT, FLEXIBLE ACOUSTIC BARRIER FOR CONSTRUCTION SITE NOISE REDUCTION

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Abstract: Noise pollution from construction sites is a long-standing challenge, affecting both workers and nearby communities. Traditional noise barriers are often bulky, expensive, and difficult to install in fast-changing site environments. The main objective of this study was to address these challenges by designing a lightweight and flexible acoustic barrier that can be easily deployed while maintaining effective noise reduction. The noise barrier was created as a multilayer structure consisting of a sail waste film, a polydimethylsiloxane (PDMS) film layer, and a waste flexible polyurethane (PU) foam layer, resulting in a thickness of about 1 cm. The cut-off pieces from sail production were attached with hot-melt adhesive to make a continuous film. This film was then attached to the polyurethane (PU) foam and a polydimethylsiloxane (PDMS) film to improve both noise absorption and damping properties. Initial acoustic measurements are encouraging and show that the barrier is capable of reducing sound by about 40 dB at higher frequencies near 5000 Hz and by 15 to 20 dB in the mid-frequency range of 250 to 1000 Hz. Alongside its performance, the material remains lightweight, rollable and flexible, which makes it suitable for temporary installation on construction sites. These results exhibit that recycled materials combined with a multi-layer polymer structure could offer a practical and more sustainable alternative to conventional noise control solutions.

Keywords: Acoustic Barrier; Noise Reduction; Polyurethane Foam; Recycled Materials; Sustainable Construction

ICSBE25_463

EXPLORING THE STRUCTURAL PERFORMANCE OF REINFORCED CONCRETE COLUMNS RETROFITTED USING ULTRA HIGH PERFORMANCE FIBER REINFORECED CONCRETE (UHPFRC) JACKETING

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Abstract: Reinforced concrete structures are increasingly experiencing deterioration in strength due to factors such as aggressive environmental conditions, unexpected mechanical loading and other external influences. In many instances, demolition is neither practical nor economically feasible. Consequently, there is a growing global emphasis on structural retrofitting emerging as a key solution. Structural retrofitting is aimed at enhancing the load-carrying capacity, durability and safety of existing structures. This study explores the structural performance of Reinforced Concrete (RC) columns retrofitted using Ultra High Performance Fiber Reinforced Concrete (UHPFRC) jacketing. A numerical model is developed to simulate the behaviour of retrofitted columns and validation was done using existing experimental data. The modified Concrete Damage Plasticity (CDP) model is employed for material modelling, while the friction surface model is used to simulate the bonding interface between the existing column and the UHPFRC jacket. Simulation results showed that increasing the UHPRFC jacket thickness increase in axial load capacity significantly. Additionally, the post-peak behaviour became more gradual, indicating improved ductility with jackets thickness. In a separate case, applying a 40 mm UHPRFC jacket to an unconfined column enhanced the peak axial load. When internal reinforcement was incorporated within the jacket, the load capacity further increased by 71%. Moreover, the reinforced specimen exhibited a significantly more extended strain range after peak loading, confirming substantial improvement in ductility and energy absorption capacity. These findings highlight the combined effectiveness of UHPRFC confinement and internal reinforcement in enhancing both the strength and ductility of retrofitted concrete columns.

Keywords: Columns; Jacket Thickness; Reinforced Concrete; Structural Retrofitting; UHPFRC Jacket

ICSBE25_500

ADVANCING PERVIOUS CONCRETE DESIGN: EVALUATING POROSITY METHODS AND MACHINE LEARNING PREDICTION

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Abstract: Pervious concrete has gained prominence as a sustainable pavement material due to its dual capacity to provide structural strength while facilitating stormwater infiltration. The effectiveness of pervious concrete largely depends on its internal pore structure, with porosity being the most critical parameter influencing both permeability and mechanical performance. Despite the importance of porosity, multiple measurement techniques exist, potentially giving variations in accuracy and reliability. This study compares four porosity determination methods: theoretical, 2D image-based, measured (gravimetric), and striped minimum porosity, and evaluates their correlation with permeability. 75 mixes were prepared by varying aggregate size (5-25 mm), aggregate-to-cement ratio (3.0–5.0), and compaction energy (0-448.8 J). Porosity was assessed using four methods, and permeability was determined through a falling head test. Statistical analyses, including Pearson and Spearman correlations, distance correlation, and multiple regression, were performed to identify the most representative porosity. Additionally, predictive modeling of porosity from mix design parameters was carried out using mathematical regression models (Linear, 2FI, Quadratic) and advanced machine learning algorithms, with hyperparameter optimization. Results revealed that measured porosity was the most reliable predictor of permeability, demonstrating the highest correlations ($r = 0.77$, $\rho = 0.817$, $\beta = 0.494$) and strong explanatory power. The quadratic regression model achieved very high predictive accuracy (~ 99%) with a low RMSE (0.025), particularly for porosities below 0.35. However, GPR offered superior robustness, achieving ~ 92% accuracy with a lower RMSE (0.020) and improved prediction for higher porosities where conventional models deviated. Validation with external datasets confirmed that GPR consistently aligned closer to observed values within ± 20% error margins, outperforming quadratic models, which showed systematic over or underprediction. A MATLAB-based prediction of mixing parameters for desired porosity was developed. Overall, the study demonstrates that measured porosity is the most representative method, while GPR provides a robust and transferable predictive framework for porosity estimation from mix design parameters.

Keywords: Machine Learning; Mix Design; Permeability; Pervious Concrete; Porosity

ICSBE25_516

ECO-FRIENDLY TERMITE CONTROL THROUGH EVALUATING ANCIENT PRACTICES TO THE MODERN SOILBASE APPLICATIONS

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Abstract: Termite infestation poses a persistent challenge in soil-based construction, causing structural damage and economic losses. Ancient civilizations employed natural, eco-friendly termite control methods using locally available materials, providing valuable insights into sustainable pest management techniques. This study evaluates these historical traditional practices and explores their adaptation to modern construction through the use of economically viable and environmentally sustainable materials, specifically salt and fly ash. Traditional methods documented in literature and oral traditions were analyzed to identify practices effective in deterring termite activity while minimizing the adverse environmental impact. Selected practices were then experimentally applied in contemporary settings, with salt and fly ash incorporated as protective agents. Laboratory and field trials assessed their effectiveness in termite control and their influence on colony propagation. The findings indicate that several traditional methods, when combined with modern materials, offer economically viable, eco-friendly alternatives to chemical termite treatments. This approach not only enhances sustainable construction practices but also aligns with circular economy principles by reducing reliance on harmful pesticides. The study demonstrates the value of integrating Ancient Practice with modern material science, providing a framework for sustainable termite management in soil-based construction. These insights are expected to benefit researchers, industry practitioners, and policymakers in advancing eco-friendly, resilient anti-termite control solutions.

Keywords: Eco-Friendly Termite Control; Soil -Based Construction ; Traditional Practice

ICSBE25_553

VERNACULAR WINDCATCHER SYSTEMS TO ENHANCE THERMAL COMFORT IN BUILDINGS: CLASSIFICATION UPON OPERATION - A REVIEW

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Abstract: The requirement of identifying energy-efficient building strategies to optimize thermal comfort in buildings without relying on fossil fuel-driven mechanical systems has been intensified due to the rapid increase in global energy consumption over decades. Vernacular windcatcher systems, which have been practiced for centuries, stand as a sustainable green alternative strategy to harness the renewable energy forces of the local climate to ventilate the indoor spaces while enhancing the thermal comfort inside a building. This review synthesizes scholarly literature to explore the design, classification and operational mechanisms of wind catcher systems, focusing on wind-driven, buoyancy-driven and combined wind-driven and buoyancy-driven techniques, with the adoption of the evaporative cooling enhancement method to enhance the potential for cooling inside a building. This analysis delineates different operational types of windcatcher systems based on geometric configurations and environmental responses, highlighting their suitability for different climates. Key findings reveal that combined wind-driven and buoyancy-driven wind catcher systems provide the highest efficiency compared to other operational techniques and proper integration of well-designed, re-engineered vernacular windcatcher systems in contemporary buildings can significantly enhance thermal comfort while reducing energy consumption and supporting sustainable green practices in the built environment.

Keywords: Natural Ventilation; Passive Cooling; Sustainable Building Design; Thermal Comfort; Vernacular Windcatcher

ICSBE25_560

SUSTAINABLE PRODUCTION OF REINFORCED CONCRETE SLABS UTILIZING WASTE TIRE STEEL FIBERS

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Abstract: End-of-life tyres represent a growing environmental concern, with pyrolysis widely adopted to recover oil and carbon black. However, this process generates a significant amount of Waste Tire Steel Fibres (WTSFs), which are normally inadequately disposed of, hence causing soil and water pollution. The accumulation of this metallic waste poses health and ecological risks, highlighting the need for sustainable management. This study aims at the sustainable use and recycling of these WTSFs as tensile reinforcement in precast one-way concrete slab panels. The fibers from a pyrolysis unit in Puttalam, Sri Lanka, were cleaned to remove oil residues, graded into three diameter categories (A, B, C), and mechanically characterised. The medium-diameter fibers (B) performed better in terms of yield strength and were adopted for reinforcement. The slab panels of M25 grade concrete (1.524 m × 0.305 m × 0.08 m) were cast using three different reinforcement models: (i) conventional reinforcement using 8 mm steel bars, (ii) WTSF bundles arranged to emulate conventional bar spacing, and (iii) alternative WTSFs bundle distributions. After a 28-day curing period, slabs were tested under three-point bending, and a cost comparison was performed. Results indicated that Model 2 (WTSF bundles) achieved the highest flexural strength (3.92 N/mm^2), slightly better than the conventional reinforcement (3.868 N/mm^2). However, unlike conventional slabs, Model 2 exhibited sudden brittle failure with little warning, raising concerns for structural safety. Model 3 underperformed (2.203 N/mm^2) due to poor fibre distribution. The cost analysis showed that the material cost was reduced by 27%. Overall, WTSFs demonstrate potential as a circular-economy reinforcement for precast slab panels, provided bundle configuration and failure mechanisms are carefully addressed.

Keywords: Precast Slab Panels; Recycled Waste Tire Steel Fibers; Reinforced Concrete; Sustainable Construction

ICSBE25_565

ASSESSING THE EMBODIED ENERGY OF MASONRY BLOCKS INCORPORATING GLASS WASTE

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Abstract: The construction industry consumes a significant quantity of natural resources and contributes to global energy consumption as well as greenhouse gas emissions. Integrating recycled waste materials in construction is a practical approach to lower embodied energy, reduce the generation of solid waste, and promote sustainable practices. In Sri Lanka, a major concern raised is the generation of waste glass, which is approximately 2% of total municipal solid waste, that eventually ends up in landfills. This study examined the embodied energy of masonry blocks incorporating post-consumer glass waste as a partial substitute for fine aggregates. Masonry blocks were produced under controlled environments using cement, crushed glass, manufactured sand, quarry dust, and coarse aggregates. A typical block weighed approximately 22 kg and was 390 × 150 × 190 mm in dimensions. The embodied energy of a block was calculated by assessing the energy required for material extraction, processing, transportation, and manufacturing. The Glass Waste Aggregate Block (GWAB) showed an embodied energy of 0.58 MJ/kg (12.76 MJ per block), comparable to that of conventional cement blocks, which is in the range of 0.59 MJ/kg and substantially lower than fired clay bricks (in the range of 3 MJ/kg) and Autoclaved Aerated Concrete (AAC) blocks (in the range of 3.5 MJ/kg). This reduction was mostly due to the use of glass as a post-consumer material, local sourcing of aggregates, and a lower requirement for processing. The study highlighted several environmental benefits, including the reduction of landfill burdens, the saving of natural resources, the reduction of cement usage, and making the economy more sustainable by following the circular economy principles. Overall, GWAB is a useful, eco-friendly option for buildings that use less energy and resources.

Keywords: Embodied Energy; Glass Waste; Masonry Blocks; Sustainable Construction

ICSBE25_573

UNIAXIAL COMPRESSION BEHAVIOUR OF CONCRETE FILLED FIBRE REINFORCED POLYMER TUBE COLUMNS: EFFECT OF THE CEMENT CONTENT

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Abstract: Concrete-filled Fibre-Reinforced Polymer (FRP) Tubes (CFFTs) offer enhanced strength and ductility over conventional concrete columns, enabling reduced concrete volumes and lower embodied carbon. Since FRP confinement becomes effective only after matrix cracking, this study investigates the influence of reduced cement content on the axial compressive behaviour of CFFTs. Twenty glass FRP CFFTs with identical geometry and four concrete mixes – featuring 0%, 10%, 20%, and 30% reductions in cement content were tested under concentric axial compression loading. While reductions in cement content decreased the unconfined concrete strength by 3.2%, 13.7%, and 17.5%, the ultimate compressive strength of the CFFTs remained largely unchanged. These results challenge the conventional assumption that the ultimate strength of CFFTs directly depends on unconfined concrete strength, highlighting the importance of considering the complex interaction between matrix properties, cracking behaviour, and confinement effects.

Keywords: Axial Compression Loading; Cement Content Reduction; Concrete-filled FRP Tubes; Embodied Carbon; Sustainable Construction

ICSBE25_581

WORKFORCE DEVELOPMENT THROUGH MODERN CONSTRUCTION TECHNOLOGIES IN SRI LANKAN LARGE-SCALE PROJECTS

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Abstract: The awareness among the construction worker base in Sri Lanka regarding modern construction technologies, and the factors obstructing the adoption thereof in large construction projects, has been investigated in this study. Despite the rapid advancements in the construction industry worldwide through the use of technology, pre-fabrication, and automation, the construction industry in Sri Lanka still practices outdated technologies. The purpose of this paper is, therefore, threefold. First, it aims to evaluate the extent of awareness among construction site workers based in Sri Lanka regarding site-level construction technologies. Second, it aims to identify factors obstructing the adoption process. And third, it aims to provide recommendations on measures that should be taken to raise the construction base in the construction industry. The methodology adopted in this paper was a mixed approach, in which survey data was collected using an RII approach that aims to identify the awareness among the construction worker base in Sri Lanka regarding the adoption of 20 site-level construction technologies. The RII results reveal that technologies such as modular formwork, levelling lasers, and pre-fabricated construction components are better known (RII > 0.70), and those related to technology, such as Smart PPE and drone monitoring, have critically lower awareness levels in the construction industry in Sri Lanka. The interviews carried out among the construction industry experts revealed the primary factors obstructing the adoption process in the construction industry in terms of high costs, outdated training structures, cultural resistance, lack of managerial involvement, and the use of languages. The construction worker base in the construction industry in Sri Lanka is neither resistant to these technologies nor against the adoption process; they simply lack exposure.

Keywords: Construction Technology Readiness; Construction Workforce; Digital Tools in Construction; Modern Construction Technology; Modular Formwork; Peer Learning

ICSBE25_583

EFFECT OF CORROSION ON DAMPING BEHAVIOUR OF REINFORCED CONCRETE ELEMENTS

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Abstract: Reinforcement corrosion is one of the most critical deterioration mechanisms affecting the long-term performance and safety of Reinforced Concrete (RC) bridge structures. Progressive corrosion affects the reinforcement to concrete interface by inducing microcracks and change the dynamic behaviour of structural components. Nevertheless, Early detection of structural damage in a bridge is crucial for ensuring the safety and efficient maintenance. Traditional visual inspection methods, despite their widespread use, have significant limitations, encouraging interest in vibration-based condition assessment techniques. Among various vibration-based damage indicators, damping has drawn the attention of recent research due to its pronounced sensitivity to minor damage compared to natural frequency. Therefore, this study experimentally investigates the evolution of modal damping characteristics in RC elements after different levels of controlled localized corrosion in view of a nondisruptive vibration-based damage detection method. A T-shaped RC specimen was subjected to accelerated corrosion through the impressed current electrochemical technique, generating multiple severity levels of corrosion damage. Free vibration tests were conducted after each corrosion level, and the corresponding acceleration responses were processed using Variational Mode Decomposition (VMD) to isolate mono-frequency modal components. Instantaneous logarithmic decrement was evaluated using a moving window technique to capture amplitude-dependent damping behaviour. Results of the study demonstrated that the magnitude and nonlinearity of damping are significantly affected by the level of corrosion, transitioning from predominantly viscous damping at undamaged conditions to a nonlinear damping mechanism with increasing corrosion severity. The study confirmed that detection of nonlinear modal damping can be used as a sensitive and reliable damage indicator for detecting corrosion-induced damage using vibration-based condition assessment of RC bridge structures.

Keywords: Corrosion; Damping Mechanism; Instantaneous Modal Damping Ratio; Nonlinear Damping Identification; Variational Mode Decomposition

SUSTAINABLE URBAN MOBILITY: INNOVATIONS FOR LOW-CARBON, INCLUSIVE, AND RESILIENT URBAN SYSTEMS

ICSBE25_022

GEOLOGICAL CONSTRAINTS, SUSTAINABLE DESIGN AND ALIGNMENT OPTIMIZATION IN THE TWIN TUNNEL SECTIONS OF THE RUWANPURA EXPRESSWAY PROJECT - PHASE 2

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Abstract: This paper presents a multidisciplinary evaluation of the alignment optimization process undertaken for two critical segments of the Ruwanpura Expressway Project - Phase 2 in Sri Lanka. Initially conceptualized as deep cut slope corridors, the segments between chainages 29 + 000 to 29 + 500 and 38 + 200 to 39 + 800 were later reconfigured into twin tunnel alignments. This design revision was initiated by the Highway Design Division of the Road Development Authority (RDA), based on the findings of the Ruwanpura Tunnels Geological Feasibility Report (2022), which confirmed that tunnel construction would better satisfy geological, geometrical, and sustainability requirements. The revised design aligns with AASHTO geometric design standards, ensuring improved safety, drivability, and long-term resilience. Furthermore, this paper highlights how the tunnel adoption supports broader sustainability goals, particularly the United Nations Sustainable Development Goals (UNSDGs), namely SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). The findings demonstrate how integrating geological assessments with sustainable and standards-based design frameworks can enhance both engineering outcomes and environmental stewardship in large-scale transport infrastructure.

Keywords: AASHTO Standards; Geological Feasibility; Highway Design; Ruwanpura Expressway; Sustainable Infrastructure; Tunnel Alignment

ICSBE25_374

STREET SPACE ALLOCATION IN KANDY'S CITY CENTRE: INSIGHTS FROM BEST PRACTICES, SPATIAL EVIDENCE, AND PUBLIC PERCEPTIONS

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Abstract: In compact heritage cities, the way street space is allocated among competing modes of transport strongly influences urban liveability, accessibility, and sustainability. International best practices emphasise equitable distribution that prioritises walking, cycling, and public transport, yet Sri Lankan cities such as Kandy have seen little empirical analysis of how their limited street space is shared among different mobility modes. This study examines the central grid of Kandy through three complementary perspectives: (i) international benchmarks for urban street space allocation, (ii) empirical measurements of the existing allocation of street space across transport modes, and (iii) public perceptions of how space is distributed and experienced. The findings reveal significant disparities between best practice principles, physical conditions on the ground, and public perceptions. Space for pedestrians is disproportionately limited, while road space dedicated to vehicles is excessively high. Survey respondents consistently identified congestion as a serious concern for both pedestrians and motorists, yet their views on its underlying causes and potential solutions were fragmented and lacked consensus. By situating these differences within the broader discourse on sustainable urban mobility, the study contributes a context-specific evidence base for rethinking how scarce street space in Kandy's city centre can be reallocated more effectively and sustainably. The insights aim to inform future interventions that balance efficiency, accessibility, and heritage preservation in one of Sri Lanka's most important and constrained urban cores.

Keywords: Kandy; Sri Lanka; Stakeholder Perceptions; Street Space; Sustainable Mobility; Urban Sustainability

ICSBE25_430

REDESIGN OF GAMPAHA INTERCHANGE IN THE CENTRAL EXPRESSWAY PROJECT PHASE I: A SUSTAINABLE ENGINEERING APPROACH

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Abstract: The Central Expressway Project (CEP) is a major infrastructure project in Sri Lanka that seeks to improve national connectivity and foster regional economic development. In CEP Phase I, the Gampaha Interchange was initially planned as two trumpet interchanges by the design consultants. However, following a careful evaluation of the technical, environmental, and economic factors, the Highway Design Division of the Road Development Authority (RDA) changed the design to a single diamond interchange. The design change also included a toll-free link road that circumnavigates Gampaha city. This road links the Gampaha-Yakkala Road to the Gampaha-Minuwangoda Road. This redesign resulted in savings of Rs. 592 million and expected improved traffic, reduce sensitive natural habitats, and increase urban resilience. The project adheres to the United Nations Sustainable Development Goals (UNSDGs), particularly Goals 8, 9, 11, and 15. These encourage inclusive economic growth, sustainable infrastructure, creating liveable cities, and protecting biodiversity and farmland. This paper discusses the reasoning and rationale for making such a redesign, the process by which this redesign was accomplished, and the various impacts of the redesign in a multi-dimensional arena. Furthermore, the paper provides suggestions for infrastructure projects in similar contexts.

Keywords: Central Expressway Project (CEP); Diamond Interchange; New Gampaha Interchange; Sustainable Infrastructure; UNSDG

ICSBE25_569

ROAD TRAFFIC ACCIDENTS AND INFLUENCE OF VEHICLE INDOOR CHARACTERISTICS TO DROWSY DRIVING

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Abstract: With respect to the significant development of the transport sector, the improvements of vehicles utility were raised swiftly. Therefore, the Heating Ventilating and Cooling (HVAC) system was introduced to make a comfortable indoor atmosphere. With the aim of reducing traffic congestion and travel time, Sri Lanka has undertaken extensive development of road networks, highways, and related infrastructure. The road traffic accidents are now become a disaster which causes huge life and economic losses to the country. As per statistics, nearly 1.3 million people were affected by road traffic accidents annually worldwide and millions of people were disabled. 90% of them took place at low and middle-income countries. Focused to road traffic accidents, driver fatigue is a contributory factor due to lack of rest and long hours of driving, especially on long-haul driving during the night. Other reasons for traffic-related accidents were inadequate street lighting and bad road conditions. Complementary, accidents caused by fatigue & drowsiness at the wheel were increasing at an alarming rate, and less focus to find the related technical factors. Thus, this paper seeks to determine the effect of road traffic accidents due to fatigue & drowsiness in relation to the indoor air characteristics of the vehicle. The study illustrates that the indoor characteristics is significantly increase the likelihood of the vehicle driver leaving the scene, and trigger fatigue condition that leads to drowsiness because of the poor indoor air quality, CO_2 concentration & characteristics of the HVAC system. The study suggested the importance of maintaining the high degree of hygienic level in vehicles by achieving a proper design and maintaining an adequate ventilation system in the cabin's indoor environment.

Keywords: CO_2 Concentration & Characteristics of HVAC; Drowsy Driving; Indoor Air Quality; Road Traffic Accident

NEXT-GENERATION TECHNOLOGIES FOR SUSTAINABLE, RESILIENT, AND SMART FOOD SYSTEMS

ICSBE25_006

A STUDY ON THE SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF SMALL-SCALE RUBBER CULTIVATION AND ITS ASSOCIATED INDUSTRIES, CURRENT TRENDS AND PROBLEMS BASED ON OPANAYAKE GRAMA NILADARI DIVISION, RATNAPURA DISTRICT, SABARAGAMUWA PROVINCE

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Abstract: This study explores the socio-economic and environmental impacts of small-scale rubber cultivation in the Opanayake Grama Niladari Division of the Ratnapura District, Sabaragamuwa Province. Field data were collected via questionnaires and interviews. Key challenges identified include the premature aging of rubber trees due to improper tapping techniques and increased abandonment of rubber for more profitable crops like tea and cinnamon. Additionally, many young people are moving away from agriculture, resulting in a shortage of skilled labour and irregular wage systems. Poor agricultural practices, such as tapping during the rainy season and neglecting disease control, have led to higher incidences of diseases like ring leaf spot and white root rot. Rising costs of fertilizers and agrochemicals, along with fluctuating rubber prices, further threaten the sustainability of these small-scale operations. Unscrupulous labour practices and declining profits also discourage continued investment in rubber cultivation. To address these issues, the study proposes increasing awareness among growers, encouraging proper use of agricultural inputs, and adopting improved tapping methods. Vocational training is recommended to engage the younger generation in skilled agricultural labour. The study also suggests promoting intercropping and encouraging self-employment during off-hours to diversify income sources. Long-term sustainability, the study concludes, lies in empowering farmers through entrepreneurial and management training rather than reliance on government subsidies. This holistic approach aims to improve productivity, economic resilience, and environmental sustainability in the rubber sector

Keywords: Rubber; Small-scale; Tapping

ICSBE25_021

SMART AUTOMATION SYSTEM FOR QUANIFYING PLATE WASTE AND IDENTIFYING CUSTOMER NUTRIENT INTAKE IN LARGE-SCALE HOTEL BUFFET SYSTEM

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Abstract: The hospitality industry faces ongoing challenges in managing food waste and accurately assessing guest nutrient intake, particularly in buffet settings where traditional monitoring methods are labour-intensive and often imprecise while AI-driven waste-tracking system and IoT technologies like Smart-Log have shown promise in addressing these issues individually, there remains a lack of integrated solutions that simultaneously monitor nutrient intake and quantify plate waste in buffet environments. This study aims to design, develop, and validate a lab-based smart automation system that can concurrently track individual guest nutrient intake and measure food waste in large-scale hotel buffet services. The prototype was initially tested in a real buffet setting, focusing on two commonly served dishes, rice and chicken for targeted refinement. The system consists of three core components: weight sensors, a keypad-based identification and an AI-powered image analysis model. Weight sensors were used to measure both the quantity of food served to and left uneaten by each individual, allowing precise tracking of consumption and waste. The keypad system was introduced to uniquely identify each guest, enabled personalized monitoring. These components were connected via an Arduino platform to ensure real-time data collection. To analyse the composition of plate waste, a trained teachable machine image classification model (R^2 = 0.86; RMSE = 19.11) was employed, successfully identifying discarded food items by type. All connected data were integrated into a custom-developed mobile application, which incorporated a food composition database to calculate and display individual nutrient intake. The app also tracks food waste per guest and across the buffet area, offering users personalized nutritional profiles after each meal. The system encourages healthier eating habits and supports more efficient resource use. This integrated prototype presents a novel and practical approach to reducing food waste and promoting nutrient awareness in the hospitality industry.

Keywords: Food Waste; Image Processing; Nutrient Intake; Teachable Machine; Weight Sensor

ICSBE25_044

DEVELOPMENT AND QUALITY EVALUATION OF COCONUT-BASED SWEETENED SKIMMED CONDENSED MILK AND ASSESSING THE IMPACT OF SUGAR VARIETIES AND COCONUT MILK TYPES ON PRODUCT QUALITY

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Abstract: As consumer interest shifts toward healthier and plant-based alternatives, coconut has emerged as a promising substitute for conventional dairy, particularly in sweetened condensed milk production. This study aimed to develop coconut-based sweetened skimmed condensed milk and assessed how variations in coconut milk type (full cream and skimmed) and sugar type (white granulated sugar and kithul jaggery) influence its properties. Coconut milk was extracted through hydraulic pressing and formulated into four treatments: FW (full cream white sugar condensed milk), SW (skim white sugar condensed milk), FJ (full cream jaggery condensed milk), and SJ (skim jaggery condensed milk). Physicochemical, nutritional, functional, sensory, and microbiological parameters of the samples were evaluated. For sensory evaluation, milk toffee was selected as a model product. Results showed significantly higher fat content in full cream milk (15.83 ± 0.28%) compared to skimmed (3.00 ± 0.50%). Jaggery notably reduced pH values (lowest at 5.38 ± 0.13) due to its acidic nature, while Brix levels were stable across all formulations (62 – 63°). Free fatty acid value was lowest in the SJ sample (0.16 ± 0.05%), indicating better oxidative stability. The highest antioxidant activity was observed in the SJ sample (31.84 ± 0.50%), attributed to polyphenolic compounds in jaggery (2.54 ± 0.01 mg GAE/g). Moisture content ranged from 35.52% to 37.28%, and protein content from 0.42% to 0.80%. Sensory evaluation favoured FW and SJ, with overall acceptability scores of 3.80 ± 0.96 and 3.70 ± 1.05, respectively. All samples met microbiological safety standards, and storage studies revealed minimal changes in quality when refrigerated. These findings highlighted the potential of coconut skim milk and kithul jaggery in creating nutritious, stable, and consumer-accepted plant-based condensed milk, promoting sustainable use of local ingredients in functional food innovation.

Keywords: Coconut Milk; Kithul Jaggery; Physicochemical Properties; Plant-based Alternative; Sweetened Condensed Milk

ICSBE25_089

PH-INDUCED CHANGES IN COCONUT PROTEINS IN SKIMMED COCONUT MILK

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Abstract: Coconut protein is a promising plant-derived substitute for animal protein due to its well-balanced amino acid profile and better sustainability. pH changes during food processing are likely to alter coconut protein structure and functionality, affecting processability. This necessitates a better understanding of pH-induced changes in coconut proteins. Previous studies have mainly focused on pH-induced changes in whole coconut milk, reflecting the collective behaviour of proteins and fat. They do not investigate the changes in protein alone. Therefore, in this project, Skimmed Coconut Milk (SCM) containing 2.29% protein, 0.4% fat and 95.73% moisture was successfully formed first, using centrifugation. Then, the pH of SCM was adjusted from 3 to 10, and the changes in viscosity, turbidity (measured as Optical Density, OD) and emulsifying ability were analyzed using a capillary viscometer, spectroscopy and Creaming Index (CI) measurements. Visual observations revealed protein aggregation at low pH (3 to 4), with viscosity and turbidity reaching a maximum at pH 3 (0.92 Pa·s and 0.98 OD, respectively), along with a reduction in emulsifying ability (32.89% CI), likely due to proteins reaching their isoelectric point. Conversely, at neutral pH 7, viscosity (0.85 Pa·s) and turbidity (0.71 OD) were reduced, with greatly enhanced emulsifying ability (52.80% CI), likely due to net negative charge and reduced aggregation. At alkaline pH (above 8), coconut proteins exhibited low viscosity (0.84 - 0.85 Pa·s) and high turbidity (0.80 - 0.86 OD), with highly unstable emulsions reflected by a decreasing CI (43.33 - 37.80%). These changes were likely caused by protein structural unfolding and enhanced hydrophobic interactions at alkaline pH. This study demonstrates that pH significantly influences the functional properties of SCM proteins, possibly through structural changes. Future work will focus on investigating the secondary structure of coconut proteins using Fourier Transform Infrared Spectroscopy.

Keywords: Functional Properties; Isoelectric Point; pH Effects; Plant-based Protein; Protein Aggregation; Skimmed Coconut Milk

ICSBE25_091

GINGER-INFUSED OLEOGELS: A HEALTHIER AND SUSTAINABLE ALTERNATIVE TO HYDROGENATED FAT SPREADS

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Abstract: The growing health concerns associated with trans and saturated fats produced during hydrogenation-assisted margarine production have accelerated the search for safer, more sustainable spreadable food production methods. This study explores the potential of forming a healthier ginger-infused spreadable food product, using soybean and sesame oil by employing the oleogelation technique, where liquid oil encapsulating an aqueous ginger extract phase was transformed to a semisolid form using a physical transformation. First, ginger extract-in-oil emulsions were prepared at two Ginger Extract-to-Oil Ratios (GEOR) (1:10 and 1:20) and were gelled using molten beeswax as the oleogelator at concentrations of 7% and 9%. The effects of varying GEOR and Beeswax Concentrations (BC) on the physicochemical properties of the oleogels were analyzed. Visual observations of stability and oil separation index measurements revealed that the oleogels with lesser GEOR and higher BC resulted in better stability and decreased oil separation. Thermogravimetric Analysis (TGA) revealed that oleogelation improved the thermal stability with higher decomposition temperatures at 1:20 GEOR and 9% BC formulations, suggesting that these formulations may be more suitable in the production of thermally processed food. Oxidative stability was improved with beeswax concentration and for sesame oil-based oleogels, natural antioxidants caused higher oxidative stability, indicated by lower peroxide value. Soybean oil-based oleogels exhibited undesirable levels of peroxide values from the beginning. Sensory evaluation revealed that the spreadability level of the commercial margarine was achieved by the oleogelation methodology, although other sensory attributes (color, aroma, taste) need further improvements. Higher GEOR resulted in increased moisture content in both soybean and sesame oil oleogels. These findings demonstrate the potential of water-infused oleogels as viable, healthier, and more sustainable alternatives to conventional hydrogenated fat spreads. Further investigations will include evaluation of oxidation stability, texture analysis, and sensory attributes to comprehensively assess product quality and consumer acceptance.

Keywords: Beeswax; Oleogelation; Sesame Oil; Soybean Oil; Water-in-oil Emulsion

ICSBE25_113

IMPLEMENTING CIRCULAR ECONOMY PRINCIPLES TO ENHANCE SUSTAINABLE FOOD SUPPLY CHAIN: A SYSTEMATIC REVIEW

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Abstract: Food loss and waste are directly linked to the increase in population worldwide. It negatively affects the food supply chain. Circular Economy (CE) principles convert the food supply chain from a traditional linear system to regenerative systems that promote waste reduction, reduce emissions, increase resource efficiency, and promote sustainability. This study adopts a qualitative literature review of articles published between 2017 and 2025, explored from Google Scholar and Science Direct. The used keywords include "Circular Economy", "Food Supply Chain"," Digital Technology", "Sustainability" and "Resource Efficiency". The scope of 29 papers was based on using only peer-reviewed, English-language papers while excluding duplicates and papers with insufficient content. The review identifies key CE strategies, including a closed material loop system and promoting regenerative agriculture, controlling food portions, and stakeholders engaging in games like biform games. Sector-specific innovations, such as bread biorefineries and black soldier fly bioconversion that converts food waste into bio-based products or bioenergy, installation of reverse vending machines, and doggy bag facilities to take away leftovers, play a crucial role in supporting CE adoption within the food supply chain. Digital technologies like IoT, blockchain, and digital twins are the main enablers in this transition. They facilitate real-time data use, traceability, and effective consumer engagements. Policy support, cross-sector collaboration, awareness programs, and incentives are essential to successfully implement the CE food supply chain system. Despite those advantages, there are some disadvantages, like a lack of awareness, a lack of infrastructure, high cost, a lack of coordination, regulatory limits, climate impacts, segregation problems, data scarcity, and less consumer acceptance. Addressing those barriers are crucial for circular economy models. In the end, implementing CE principles can enhance the food supply chain and promote sustainability throughout the world.

Keywords: Circular Economy; Digital Technologies; Food Supply Chain; Resource Efficiency; Sustainability

ICSBE25_124

EXPLORING BRUCELLOSIS IN SRI LANKA: INSIGHTS, CHALLENGES AND IMPLICATIONS FOR PUBLIC HEALTH: SCIENTIFIC REVIEW

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Abstract: Brucellosis, a significant zoonotic bacterial infection, poses substantial public health and economic challenges in Sri Lanka, affecting both humans and livestock. Introduced during World War II, brucellosis is endemic in regions such as the North-Western and North Central Provinces. Transmission primarily occurs through contaminated food, direct animal contact, and aerosol exposure, with rare cases via blood transfusion or sexual contact. This review synthesizes findings on seroprevalence, risk factors, and public health impacts of brucellosis in Sri Lanka. Human infections, predominantly caused by *Brucella abortus*, show a seroprevalence of 8.4% (2011 – 2021), with farmers, livestock handlers, and veterinarians at the highest risk. In livestock, *Brucella abortus* biovar 3 is the primary strain, causing reproductive issues like spontaneous abortions, particularly in arid regions. Despite diagnostic advancements, the absence of a national surveillance system hampers control efforts. The COVID-19 pandemic further disrupted disease monitoring. Farmer awareness remains critically low, with only 8.3% linking brucellosis to cattle abortions and 2.6% recognizing its zoonotic potential, highlighting a significant educational gap. This review underscores the urgent need for an integrated One Health approach, combining improved surveillance, laboratory capacity, and farmer education. Addressing these gaps is vital to mitigating brucellosis's public health and economic impacts. Strengthening multidisciplinary collaboration can reduce the disease burden, support livestock-dependent livelihoods, and establish a sustainable framework for controlling brucellosis in Sri Lanka.

Keywords: *Brucella abortus*; Brucellosis; Livestock; Seroprevalence; Sri Lanka; Zoonotic Infection

ICSBE25_126

AN ANALYSIS OF THE CHALLENGES IN EXTENSION AND ADVISORY SERVICES IN THE CINNAMON INDUSTRY, SOUTHERN PROVINCE OF SRI LANKA

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Abstract: Ceylon cinnamon, known as the true cinnamon which generates significant foreign income for the Sri Lankan economy. Currently, cinnamon acts as one of the main plantation crops which provides considerable income opportunities for rural areas. However, present extension and advisory services are continuing to follow traditional methods to disseminate farming knowledge among the stakeholders in the cinnamon value chain. Additionally, there are lack of academic researches related to extension and advisory service in the cinnamon industry. Therefore, this study exposes the key challenges of extension and advisory services in the cinnamon industry. Moreover, primary data were gathered from 350 cinnamon farmers and peelers in Southern Province using the snowball sampling technique. Mainly Friedman test was applied to analyze the gathered data. Results revealed that the limited number of extension officers available is the main challenge (Mean rank = 1.70) while difficulty in understanding or applying the advice provided by extension officers in the cinnamon industry (Mean rank = 5.27) is a less significant challenge when farmers and peelers interact with the government extension officers. Moreover, the lack of communication and collaboration between extension officers and researchers (Mean rank = 1.68) is the main challenge, whereas limited awareness of available research or innovations in cinnamon farming (Mean rank = 3.58) is a minor challenge faced by cinnamon farmers and peelers in terms of linkages between extension services and research institutions for cinnamon farming. Additionally, infrequent visits or evaluations (Mean rank =1.60) is a major barrier, while the absence of clear action plans based on evaluations by extension and advisory officers (Mean rank = 2.27) is a less significant challenge faced by farmers and peelers in the monitoring and evaluation process within the cinnamon industry. This study gives meaningful insight for future researchers and policymakers to develop strong extension services in the cinnamon industry.

Keywords: Agricultural Communication; Ceylon Cinnamon; Challenges; Knowledge Dissemination

ICSBE25_198

EFFECT OF CLOVE BUD AND NEEM LEAF EXTRACT ON LOW-DENSITY POLYETHYLENE (LDPE) FOR ACTIVE ANTIBACTERIAL FOOD PACKAGING MATERIAL

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Abstract: Food spoilage from foodborne pathogens is a serious concern, and ensuring food quality is significant for consumer health. This research designed an active antibacterial food packaging by using natural additives, clove (*Syzygium aromaticum*) bud and neem (*Azadirachta indica*) leaf extracts as a solution. Extracts from these plants were coated on the Low-density Polyethylene (LDPE) film pre-treated with chromic acid to improve the coating adhesion. The efficacy of the prepared packaging material was evaluated using the agar disk diffusion method. Six bacterial strains have been used to test the material: *E. faecalis*, *S. aureus*, *L. monocytogenes* (gram-positive), *E. coli*, *S. typhi*, and *P. aeruginosa* (gram-negative). A 1:1 (w/w) mixture showed superior inhibitory effects compared to individual activity, displaying the maximum inhibition diameter (mm) for *E. coli* and the minimum for S. typhi of 21.37 ± 0.55d and 10.00 ± 0.00a, respectively. Both clove and neem extracts, the primary natural additives used in this novel packaging, are readily available, signifying a feasible approach to this solution. The packaging material was characterised using UV-vis, ATR-FTIR, TGA, and tensile testing to confirm its properties. In model food testing, the total plate count on chicken samples showed a significant reduction from 84.95×10^{-2} logCFU/ml (reference) to 64.70×10^{-2} logCFU/ml on the first day, monitored over a 7-day period, and this product consistently displayed a lower Total Plate Count (TPC) compared to the reference. Notably, the prepared film acted as a UV barrier and exhibited similar mechanical properties due to the coating.

Keywords: Active Antibacterial; Clove Bud Extract; Low-density Polyethylene; Neem Leaf Extract; Packaging; Surface Treatments

ICSBE25_219

GENETIC AND MORPHO-PHYSIOLOGICAL ANALYSES OF THE TOLERANCE AND RECOVERY MECHANISMS IN VEGETATIVE STAGE COWPEA UNDER DROUGHT STRESS

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Abstract: Cowpea [*Vigna unguiculata (L.) Walp.*] is an important legume crop known for its resilience to drought conditions in Sri Lanka. This study evaluated drought tolerance with recovery mechanisms and genetic diversity in seven cowpea varieties, namely MI-35, MICP1, ANKCP1, ANKCP2, Dhawala, Bombay, and Waruni, using drought-responsive morpho-physiological parameters and Simple Sequence Repeat (SSR) markers. Plants were grown in a Completely Randomised Design (CRD) under controlled and drought-induced conditions, and morpho-physiological traits were recorded at the end of a 21-day drought period (imposed 23 days after planting) and again after a 14-day re-watering phase to assess recovery. Morphological data and molecular data were analysed using R (Version 4.4.0) and POWER MARKER (version 3.25) software. The Relative Values (RV) were calculated and analysed using one-way ANOVA and Tukey's test. Significant varietal differences were observed, with ANKCP2 exhibiting the highest relative performance in plant height (0.89), relative water content (17.44%), leaf area, Chlorophyll content, and root traits, indicating strong drought adaptation and recovery response. In contrast, Dhawala performed poorly on several parameters. It had a low relative water content (4.86%) and Chlorophyll content. Indicating high drought sensitivity. Principal Component Analysis (PCA) and a dendrogram were used to visualise varietal differences. It revealed that showed that ANKCP2 had good performance under both drought and recovery responses. Cluster analysis grouped MI-35 and Dhawala together and ANKCP2 in its own group. Genetic diversity was evaluated using five SSR markers; these markers showed moderate polymorphism, with a mean PIC value of 0.5451. The UPGMA dendrogram that used SSR data split the types into two main genetic clusters, Dhawala and MI-35, were grouped into formed a genetically distinct cluster. confirming different genetic makeups. These results highlight ANKCP2 as a genetically diverse and physiologically resilient variety, suitable for future breeding programs.

Keywords: Cowpea; Drought Recovery; Drought Tolerance; Genetic Diversity; SSR Markers

ICSBE25_220

ASSESSMENT OF GENETIC DIVERSITY AND DROUGHT TOLERANCE WITH POST-STRESS RECOVERY OF SELECTED SRI LANKAN BLACK GRAM (*Vigna mungo*) VARIETIES

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Abstract: Black gram (*Vigna mungo L.)* is an important legume crop in Asia. They have a relatively short life span and a high nutritional composition. This study assessed drought tolerance and genetic diversity in four Sri Lankan Black gram varieties (MI 01, Anuradha, MIBG 3, and MIBG 4) using drought-responsive morpho-physiological parameters and Simple Sequence Repeat (SSR) markers. Plants were grown in a Completely Randomised Design (CRD) under controlled and drought-induced conditions. Morpho-physiological traits were recorded at the end of the 21st day of the drought period (imposed 23 days after planting). Recovery was assessed after a 14-day rewatering phase. Significant varietal differences were observed, with MIBG 4 exhibiting the highest relative performance in plant height (0.82), relative water content (11.50), leaf area, chlorophyll content, and root traits, indicating a strong drought adaptation and recovery strategy. In contrast, Anuradha performed poorly on several parameters. It had a low relative plant height (0.51) and high wilting score (4.0), indicating high drought sensitivity. Principal Component Analysis (PCA) revealed that MIBG 4 was associated with leaf-based drought adaptation traits, while MI 01 and Anuradha showed weak water use efficiency traits, and MIBG 3 showed a distinct strategy driven by root morphology. Cluster analysis grouped MI 01 and Anuradha together. MIBG 3 formed a separate cluster on its own. Molecular analysis using 5 SSR primers showed moderate genetic diversity. The SSR-based dendrogram showed that MI 01 and MIBG 4 have a close genetic relationship. Anuradha and MIBG 3 formed a genetically distinct cluster. The largest genetic distance observed between Anuradha and MIBG 4. These findings indicate that MIBG 4 is a drought-tolerant and genetically diverse variety. It is suitable for cultivation in water-limited environments. It also has the potential to be a valuable parent in Black gram breeding programs.

Keywords: Black Gram; Drought Recovery; Drought Tolerance; Genetic Diversity; SSR Markers

ICSBE25_242

EVALUATION OF BASIL MUCILAGE (*Ocimum basilicum*) AS A FAT ABSORPTION REDUCER IN FRIED CASSAVA CHIPS

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Abstract: Many studies have found that fried food contains more than 50% excessive oil, and it can cause health problems. The objective of this study is to evaluate the effectiveness of Basil Seed Mucilage (BM) in reducing Oil Absorption (OA) during the deep-frying of Cassava Chips (CC), while analyzing the nutritional, functional, and physicochemical properties of the extracted BM. Phytochemical properties were evaluated using an ELISA and a UV-visible spectrophotometer. After the BM was extracted, the properties of the BM powder were analyzed. Using a dipping method, BM was applied to CC at varying concentrations (0.5%, 1%, and 2%). The reduction in OA for each treated sample was determined using the Soxhlet extraction method. To evaluate the practical effectiveness, the BM-coated sample was compared with a Market CC Sample (MS). BM showed a moderate moisture content (11.61 ± 1.39%) and a moderate crude fiber content (22.68 ± 2.62%). The mucilage showed functional properties with high oil holding capacity (6.95 ± 0.01 g/g), water-holding capacity (22.89 ± 1.6 g/g), and swelling capacity of 6.83 ± 0.35 ml/g. Antioxidant activity was recorded as 0.5 ± 0.06 mmol TE/g, with total polyphenols of 0.76 ± 0.03 mg GAE/g. Among all tested concentrations, 0.5% BM had the highest OA reduction value of 26.18% and the highest moisture retention (149.02%). When compared with the MS, which showed 28.44% OA, the 0.5% BM-treated CC sample exhibited significantly lower OA (18.43 ± 0.1%). According to color and texture profile evaluation, the BM 0.5% treated sample closely matched the MS, indicating its effectiveness in the practical world. Overall, 0.5% BM can be considered an effective natural edible coating to reduce OA. By replacing synthetic methods with plant-based, Biodegradable Alternatives (BM), this approach supports cleaner processing and promotes sustainable food innovation.

Keywords: Deep Frying; Edible Coating; Oil Absorption; Soxhlet Extraction; Sustainable Innovation

ICSBE25_308

DESIGN AND PERFORMANCE EVALUATION OF AN INFRARED DRYER FOR PADDY DRYING

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Abstract: This study focuses on the design, fabrication, and performance evaluation of a laboratory-scale infrared dryer for drying paddy. Open sun drying is commonly used immediately after harvest in many rice-producing regions due to its low operational cost. However, this traditional method presents significant challenges, including long drying times, dependence on weather conditions, and high susceptibility to dust, insects, and animal contamination. Additionally, uneven moisture removal and uncontrolled drying rates often lead to grain cracking, reduced head rice yield, and substantial postharvest losses. To address these limitations, a prototype infrared dryer was specifically developed for paddy pre-drying. The system includes two ceramic infrared heaters (29.5 cm × 9.5 cm), a rotary feeding mechanism, and an inclined cylindrical drying chamber (set at a 29.13° angle, 102 cm long, 25 cm in diameter) that allows gravity-assisted flow of paddy. The dryer was designed to ensure uniform heat distribution and controlled residence time for efficient moisture removal. Experimental trials were conducted using freshly harvested paddy with an initial moisture content of approximately 22% (w.b.). The dryer was operated at feeding rates of 4 kg/h to 10 kg/h, with a residence time of 55 to 116 seconds, and paddy bed temperatures ranging from 53 ºC to 80 ºC, while the infrared wavelength ranged from 8.70 µm to 7.60 µm. Results showed that the system effectively reduced the moisture content to approximately 17% (w.b.) in a single pass. The findings indicate that infrared drying provides a viable solution for on-farm or immediate post-harvest pre-drying applications. The compact design and compatibility with the feeding mechanism emphasize its potential for integration with combine harvesters.

Keywords: Infrared Drying; Moisture Reduction; Postharvest Technology; Rotary Feeder

ICSBE25_343

PRECISION AGRICULTURE IN SUGARCANE FARMING: A SYSTEMATIC REVIEW OF FARMER ADAPTATION FOR EFFICIENCY AND SUSTAINABILITY

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Abstract: Precision Agriculture (PA) is a paradigm shift in sugarcane farming to which cutting-edge technologies are introduced to vastly increase production efficiency and promote sustainability. This systematic review assesses how sugarcane farmers adopt PA practices, including how these challenges and opportunities fit in terms of Agriculture 4.0. The central aim of this study is to critically evaluate the impacts of PA implemented in sugarcane farming and measurable indicators, such as production efficiency, resource efficiency, and sustainability indicators. We systematically reviewed 40 scientific articles published between 2002 and 2024 in ScienceDirect, Google Scholar and Web of Science databases. We followed the PRISMA framework in terms of selecting the studies that were included and excluded from the selection criteria. The research shows that the use of PA technologies, including optical remote sensing and GPS-guided systems, has significantly increased operational efficiency, with some farmers enjoying reductions in labor of more than 50%. Major impediments to adoption are technological complexity, high initial costs and low awareness of potential benefits of PA among farmers. An important variable influencing adoption rates is the age of the farmer, and the farmer's level of education and access to subsidies. Introducing PA practices in sugarcane farming makes farming operations productive, environmentally friendly, and economically viable. These findings show that policymakers and technology developers need to develop targeted interventions that ease the transition towards sustainable sugarcane production systems for the benefit of farmers and the agricultural community.

Keywords: Agriculture 4.0; Farmer Adaptation; Precision Agriculture (PA); Sugarcane Farming; Sustainability

ICSBE25_373

PROTEIN REQUIREMENTS AND VIABLE NUTRITIONAL STRATEGIES FOR *Apis cerana* COLONIES IN SRI LANKA

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Abstract: This research assessed the impact of protein supplementation on *Apis cerana* colonies in Sri Lanka at the peak of death (March-July 2025) when the nutritional stress and floral availability are poor. The study was meant to find out if locally available protein-rich diets were able to maintain colony health and productivity in forage-scarce environments. In the study, four treatment groups were put in place, including the control (natural forage), Diet 1 (chickpea-based), Diet 2 (black gram-based), and a commercial protein mix. A 120-day feeding period was observed and measurements were made in colonies, brood area, pollen and honey storage and adult bee populations. Control colonies consistently achieved the highest values across all parameters, with brood areas of 540.8 cm^2, pollen stores of 80.6 cm^2, honey reserves of 230 cm^2, and adult populations of 2,193 bees. This superior performance was largely due to their placement in low-density apiary sites with better access to abundant natural forage. Among the supplemental diets, the chickpea-based formulation (Diet 1), enriched with date paste, performed best, maintaining brood areas of 327.7 cm^2, pollen stores of 50.2 cm^2, and adult populations averaging 1,087 bees. Diet 2 (black gram–based) provided moderate support, while the commercial protein mix performed poorest, with brood areas of 228.3 cm^2 and adult populations of 809.9 bees. Statistical analysis confirmed that honey storage ($p = 0.036$) and total adult bee population ($p = 0.054$) differed significantly, specifically between the control and commercial groups, highlighting the limitations of imported feeds under local dearth conditions. which demonstrated the drawbacks of imported feeds during dearth periods in the locality. These findings indicate that natural forage diets cannot be replaced, though locally developed chickpea-based diets may be effective and cheap supplements to keep the colony healthy in times of floral deficiency. By alleviating nutritional stress, such diets reduce colony decline, minimize absconding, and maintain productivity. Implementing context-specific, climate-adapted feeding strategies provides a practical approach for smallholder and rural beekeepers in Sri Lanka, promoting sustainable and resilient apiculture.

Keywords: *Apis cerana*; Brood Area; Comb Development; Death Period; Floral Availability; Foraging Behaviour

ICSBE25_455

NUTRITIONAL AND PHYSICOCHEMICAL PROPERTIES OF PASTA BASED ON SUCKERMOUTH CATFISH (*Pterygoplichthys sp.*) FLESH POWDER

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Abstract: Suckermouth catfish (*Pterygoplichthys sp.*) is an invasive and underutilized fish species causing ecological and economic harm to Sri Lanka's freshwater ecosystems and fisheries sector. This study evaluated the impact of partial substitution with suckermouth catfish flesh powder (SFP) on the nutritional profile and physicochemical properties of pasta. Value-added application for the flesh of the fish was investigated by formulating three pasta types: control pasta (0% SFP), Pasta with 10 g of SFP (PSFP 10%), and Pasta with 15 g of SFP (PSFP 15%). Semolina flour is used to produce the pasta, and fish powder was added to partially replace the flour amount. Corn flour (4 g) and a cinnamon–pepper powder mixture (0.5 g) was added to all three products. Cooking qualities, texture profile, color parameters (L*, a*, b*), The optimal formulation was determined through sensory assessment. With increasing SFP, optimal cooking time increased from 11.57 ± 0.12 min to 13.35 ± 0.07 min, and cooking loss rose from 2.43 ± 0.03% to 3.82 ± 0.05%. Swelling index decreased from 0.37 ± 0.1 to 0.23 ± 0.1, while weight gain and water absorption index were not significantly affected. Texture profile analysis showed hardness increased from 55.43 ± 1.06 N to 2.14 ± 0.80 N, springiness from 3.03 ± 0.25 to 3.64 ± 0.32, gumminess from 13.62 ± 0.54 to 49.28 ± 0.87, and resilience from 0.19 ± 0.05 to 0.32 ± 0.05. Adhesiveness decreased from 0.27 ± 0.12 to 0.12 ± 0.05. Color measurements indicated SFP-supplemented pasta had lower lightness and redness but higher yellowness. Sensory evaluation by 30 untrained panelists indicated consumer acceptance declined as the SFP level increased. Considering both sensory and physicochemical results, PSFP 10% was the optimal formulation, exhibiting 18.17 ± 0.06% crude protein, 3.2 ± 0.1% moisture, and 76.08 ± 0.14% carbohydrate. Incorporating 10% SFP significantly improves pasta's nutritional profile without compromising quality. Thus, suckermouth catfish flesh has potential as a sustainable pasta ingredient, helping manage this invasive species while providing an alternative protein source for future food innovations.

Keywords: Fish-Based Pasta; Invasive Species Management; Physicochemical Properties; Sensory Evaluation; Suckermouth Catfish

FIRE SAFETY ENGINEERING IN SUSTAINABLE BUILDINGS

ICSBE25_284

EVALUATION OF FIRE PERFORMANCE OF MASONRY USING EXPERIMENTAL AND NUMERICAL INVESTIGATIONS: A REVIEW

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Abstract: Masonry, one of the oldest and most traditional materials, is recognised for its strong performance under elevated temperature conditions. Like other construction materials, masonry experiences complex temperature-dependent physicochemical transformations and phase changes when subjected to high-temperature exposure. These behavioural variations are represented using temperature-dependent material models, which can be determined both experimentally and numerically. This review paper examines the fire performance of masonry structures, emphasising the integration of experimental and numerical methods to address gaps in fire safety design and standardisation. The study synthesises findings from full-scale and Wallette-based fire tests, analysing thermal and structural responses under standard fire curves (e.g., ISO 834, AS 1530.4, ASTM E119). Numerical modelling, encompassing micro, macro, and homogenised methodologies, is evaluated for its capability to predict thermal gradient development, progressive material degradation, and residual load-bearing capacity. Micro-modelling captures detailed brick-mortar interactions, while macro-modelling offers computational efficiency for large-scale structures, though it has limitations with localised failure mechanisms. Key challenges include the scarcity of temperature-dependent material properties, high computational demands, and limitations in standardised testing. The review emphasises the need for enhanced experimental data, refined constitutive models, and hybrid multi-scale simulations to improve predictive accuracy and inform fire-resistant design.

Keywords: Experiment; Fire Performance; Homogenisation; Masonry; Numerical Analysis

ICSBE25_367

BRIDGING THE GAP: UNDERSTANDING FIRE SAFETY NEEDS OF OLDER ADULTS IN HIGH-RISE ENVIRONMENTS

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Abstract: This research addresses a notable gap in the existing literature on fire safety within the built environment, emphasizing the specific needs of diverse age groups, with a focus on older adults. The study contributes to filling this void by investigating the unique challenges faced by older adults during high-rise fire incidents, considering their physical limitations and heightened vulnerability. The research paper revolves around a preliminary diagnostic survey aimed at identifying and validating the issues and challenges experienced by older adults during fire evacuations. Environmental-behaviour research methods were employed for this purpose. The primary objective was to collect relevant data and evaluate the feasibility and scope of a more comprehensive study or intervention in this crucial domain. To address the concerns of older adults during fire evacuations, three distinct exercises were conducted. Firstly, environmental observations were carried out on four high-rise buildings in Ahmedabad, India, which had experienced fire incidents, examining compliance with fire safety provisions. Secondly, the environmental-behaviour method was applied, involving twelve purposely sampled participants who responded to open-ended questionnaires. Lastly, content analysis of data from the primary survey was conducted through recording, transcribing, and coding. This research contributes valuable insights to the discourse on fire safety, with a particular emphasis on the often-overlooked demographic of older adults.

Keywords: Evacuation Challenges; Fire Safety; High-rise Buildings; Older Adults; Preliminary Diagnostic Survey

ICSBE25_395

A REVIEW ON FIRE PERFORMANCE OF LSF WALLS EXPOSED TO FIRE ON BOTH SURFACES

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Abstract: Evaluating fire performance accurately is an important parameter to be considered during building construction because thousands of lives and millions of properties are lost annually due to fire damage. Fire performance can be evaluated under insulation, integrity, and load-bearing criteria for a structural element. The exposed surface of the fire is also a key factor when evaluating the fire performance. While most of the studies evaluate the fire performance of fire-separating walls exposed to fire on a single side of a wall, limited attention has been given to fire exposed to both sides of such walls. It is important to investigate fire exposure on both sides of walls, as internal walls may experience Both-sided Fire (BSF) in certain critical situations. Therefore, this paper provides a comprehensive review of both side fire exposure of LSF walls, highlighting the significant impact of such incidents and indicating the limitations of previous studies. A comparison between the effects of BSF and Single-sided Fire (SSF) using literature is also discussed, along with potential strategies to increase the fire resistance of walling materials exposed to BSF. Lack of experimental validation, the inadequacy of existing design guidelines for design walls exposed to BSF, and further studies on BSF using performance-based approaches are also highlighted.

Keywords: Fire Performance; LSF Walls; Single

ADVANCING ALTERNATIVE AND CLEAN ENERGY SYSTEMS FOR A CARBON-NEUTRAL FUTURE

ICSBE25_078

GIS-BASED MULTI-CRITERIA SPATIAL APPROACH TO MODEL OPTIMAL LOCATIONS FOR SOLAR POWER PLANTS IN SRI LANKA

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Abstract: Energy demand has gradually increased due to the global economic crisis resulting from the epidemic situation faced in recent years. The need for alternative renewable energy sources has emerged to reduce greenhouse gas emissions and environmental pollution caused by the use of fossil fuels for energy production. Among these renewable energy sources, solar energy stands out as a major potential, economically viable, and freely capturable energy source in Sri Lanka. As a tropical country located near the equator, Sri Lanka is well-positioned to harness solar energy. While a solar resource atlas exists in Sri Lanka, there is no map specifically designed to identify suitable locations for establishing solar power plants. However, it is crucial to determine optimal locations for installing solar power plants, as solar potential depends on various spatial factors. This study introduces spatial approaches to determine potential areas for solar power plant installations, including the road network, power grid, land use, slope, and Global Horizontal Irradiance (GHI). However, these factors do not contribute equally to the selection of potential sites for installing solar power plants. Therefore, this study aims to assess the contribution of each causal factor to the selection of potential sites and to identify and map the optimal locations for installing solar power plants in Sri Lanka. Geographic data corresponding to these factors were collected and converted into a raster format with the same spatial resolution for each criterion. In GIS-based environments, the Analytic Hierarchy Process (AHP) and Spatial Multi-Criteria Decision Making (MCDM) models were utilized to identify the contribution levels (weights) of each determining factor. Finally, comprehensive overlay operations were conducted to identify potential locations for installing solar power plants. The entire study area was classified into four zones: high potential, potential, less potential, and no potential.

Keywords: AHP; GIS; MCDM; Solar Power Potential; Sri Lanka

ICSBE25_180

FAULT REACTIVATION AND INDUCED SEISMICITY DURING UNDERGROUND HYDROGEN STORAGE IN DEPLETED HYDROCARBON RESERVOIRS

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Abstract: Geological hydrogen storage in depleted hydrocarbon reservoirs is appreciated as a viable strategy for achieving net-zero carbon emission goals. Among the various challenges associated with this process, the potential seismogenic reactivation of faults, which feature field-scale heterogeneity in the reservoir rock, has emerged as a pressing concern and is therefore thoroughly reviewed in this study. Hydrogen storage can reactivate faults through multiple mechanisms, resulting in alterations to the in-situ stress state and frictional properties. Hydrogen injection reduces a fault's shear strength, as increased pore pressure lowers the effective normal stress, and gas lubrication of the faulted surface decreases the friction coefficient. Hydrogen's higher mobility causes rapid gas migration and faster pressure alterations in the faulted zones. Hydrogen fingering and gravitational segregation cause uneven pressure distribution, resulting in localized stress concentrations near faults. Iron-bearing clay minerals in fault gouges react with injected hydrogen, resulting in hydrogen sorption onto the clay particles and their subsequent swelling, which both critically stresses the faults and lubricates the faulted surface. Water generated from the biogeochemical reactions can also serve as a lubricant in the faults. Biogeochemical reactions cause mineral dissolution and precipitation, which modify the fault surface and alter its frictional properties. Mineral precipitation reduces the porosity and permeability of the reservoir rock, leading to pressure buildups and potentially reactivating faults. Reviewing the existing literature has highlighted several gaps in the related studies. Previous research has yielded contradictory findings on the effect of cyclic fluid injection on promoting seismic fault slip events. The use of non-hydrogen pore fluids, poor replication of reservoir conditions, and finite sample dimensions in laboratory-scale injection-driven shear tests have limited the applicability of their findings to hydrogen storage. Therefore, experiments should be designed to use hydrogen as the pore fluid, replicate subsurface conditions, and use higher sample count and dimensions.

Keywords: Fault Reactivation; Induced Seismicity; In-situ Stresses; Underground Hydrogen Storage

ICSBE25_224

THE ROLE OF REGIONAL COOPERATION IN ADVANCING SUSTAINABLE AVIATION FUEL (SAF) DEVELOPMENT

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Abstract: Effective decarbonisation pathways are desperately needed as aviation is one of the fastest-growing sources of greenhouse gases and accounts for more than 2.5 percent of total CO_2 emissions globally. With potentially reduced life cycle emissions by as much as 80%, Sustainable Aviation Fuel (SAF) has become an attractive alternative to traditional jet fuel. While regional initiatives and policy frameworks have sped up the development of SAF on the North American and European fronts, legislative inconsistencies, infrastructure constraints, and high production costs have rendered Asia's progress sluggish and disjointed. In order to study SAF production technologies, feedstock availability, certification requirements, and international partnership models like ReFuelEU and CORSIA, this study uses a comprehensive literature review approach. The results show that the uptake of SAF in Asia could be radically boosted while enhancing energy security through collective regional cooperation, especially in the harmonization of certification standards, policy framework alignment, as well as consolidating spending. Strategic recommendations on creating public-private partnerships, formulating region-specific road maps, and facilitating cross-border SAF partnerships are laid out in the study conclusion. All things considered, the study demonstrates that the way of organizing regional cooperation can be a catalyst for making sustainable aviation a reality in Asia and meeting global climate objectives.

Keywords: Certification Standards; Decarbonization; Feedstock Logistics; Policy Harmonization; Regional Cooperation; Sustainable Aviation Fuel (SAF)

ICSBE25_304

MECHANICAL BEHAVIOUR OF COMPOSITE MATERIALS IN CRYOGENIC ENVIRONMENTS: A PROPOSED TESTING APPROACH

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Abstract: Cryogenic environments, particularly those below 120 K, pose unique challenges for selecting structural materials. These extreme conditions are central to advanced technologies such as superconducting magnets, liquid hydrogen storage, and aerospace propulsion systems. At such low temperatures, materials often experience significant changes in mechanical behaviour, typically exhibiting increased strength but sharply reduced ductility. These effects can compromise structural reliability, highlighting the importance of selecting materials that maintain both strength and toughness under cryogenic conditions. While metals such as austenitic stainless steels, aluminium alloys, and titanium alloys are commonly used due to their retained toughness, Fibre-reinforced Polymer Composites (FRPs) offer significant advantages in terms of specific strength and weight reduction. This makes them particularly attractive for next-generation cryogenic structures where structural efficiency is critical. This work presents a planned experimental investigation aimed at characterising the mechanical behaviour of Carbon Fibre Reinforced Polymers (CFRP) and Glass Fibre Reinforced Polymers (GFRP) under cryogenic conditions. Composite laminates will be fabricated using the Vacuum Assisted Resin Transfer Moulding (VARTM) process to ensure uniformity and scalability. To enhance matrix-dominated properties, a selected nanomaterial will be incorporated into the resin to improve toughness, interfacial bonding, and thermal stability. Mechanical characterisation will be performed at both room temperature and 20 K using a custom-designed cryostat capable of conducting low-temperature tensile testing. Key parameters to be evaluated include tensile strength, Young's modulus, and failure strain, with particular attention to failure mechanisms influenced by matrix and interface behaviour at cryogenic temperatures. The objective is to develop a comprehensive understanding of how nano-enhanced composite systems perform in extreme cryogenic environments. Findings from this study are expected to guide material selection and structural design strategies for lightweight, high-performance cryogenic storage and transport systems, with direct implications for aerospace, energy, and hydrogen infrastructure applications.

Keywords: CFRP; Cryogenic Materials; Cryogenic Testing; GFRP; Matrix-modification

ICSBE25_313

HARNESSING PEDESTRIAN POWER: A REVIEW OF FOOTSTEP ENERGY GENERATION AS A GREEN ENERGY SOLUTION FOR SRI LANKA

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Abstract: As urban populations continue to grow and the global demand for clean energy intensifies innovative methods of harvesting ambient energy have gained significant attention. Footstep energy harvesting, which is a technique that captures and converts the kinetic energy generated from human walking into electrical energy, emerges as a promising and under-explored green energy solution. This review investigates the underlying mechanisms of footstep energy technologies, focusing on the use of piezoelectric and electromagnetic systems, and evaluates their potential to contribute to Sri Lanka's renewable energy portfolio. By examining successful implementations in technologically advanced nations such as the United Kingdom, Japan, and the Netherlands, this paper extracts key lessons in system design, user interaction, and performance optimization. The Sri Lankan context is explored in depth, identifying high-footfall locations like railway stations, public markets, educational institutions, and religious sites where footstep energy systems could be most impactful. The review further discusses the predicted energy output, environmental and socio-economic advantages, and the infrastructure synergies obtainable through integration with smart city initiatives. It also explores technical limitations, financial barriers, and social acceptance problems, proposing a set of strategic recommendations containing pilot projects, public-private partnerships, academic collaborations, and supportive policy reforms. This comprehensive overview locates footstep energy harvesting not only as a supplementary power source but also as a tool for boosting sustainability, technological innovation, and community engagement in Sri Lanka's urban development landscape.

Keywords: Footstep Energy Harvesting; Piezoelectric Systems; Renewable Energy in Sri Lanka; Smart City Integration; Sustainable Urban Development

ICSBE25_316

IMPACT OF UNDERNEATH TEMPERATURE AND VENTILATION STRATEGIES ON SOLAR PV POWER GENERATION

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Abstract: Solar Photovoltaic (PV) systems are increasingly adopted in tropical countries, yet their performance is strongly influenced by thermal conditions, particularly the buildup of heat underneath the modules in rooftop installations. This study experimentally evaluates how underneath temperature affects PV module power generation and examines the influence of mounting height and ventilation strategy on thermal and electrical performance. Field trials were conducted in Siyabalanduwa, Sri Lanka, using Trina Solar 605 W monofacial modules mounted at four elevations (100 mm, 125 mm, 150 mm, and 175 mm) under both natural and forced ventilation. Key parameters, including underneath and surface temperatures, ambient temperature, solar irradiance, wind speed, and power output, were measured at 20-minute intervals from 10:00 a.m. to 2:00 p.m. Results revealed a clear inverse relationship between underneath temperature and power output in naturally ventilated systems, with higher mounting heights achieving better passive cooling. Forced ventilation reduced underneath temperatures by 2.5–3 °C and increased peak power output by up to 300 W, particularly at the 175 mm elevation. Statistical analysis showed strong linear correlations between temperature and power output under natural ventilation ($R > 0.89$), while fan-assisted systems displayed more stable, non-linear performance trends due to thermal regulation. The findings emphasise the importance of adequate mounting height and targeted active cooling in hot, humid climates to sustain high PV output and system longevity. Practical guidelines are proposed for optimising air-gap design and ventilation, offering valuable insights for engineers, installers, and policymakers aiming to enhance solar energy efficiency in tropical regions.

Keywords: Mounting Height; Power Generation Efficiency; Solar Photovoltaic; Underneath Temperature; Ventilation

ICSBE25_327

CFD ANALYSIS OF CROSSFLOW AIR TURBINES IN OSCILLATING WATER COLUMN SYSTEMS UNDER IRREGULAR FLOW

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Abstract: Oscillating water columns are increasingly recognized as a practical solution for harnessing marine renewable energy, with Crossflow Air Turbines (CFATs) serving as an alternative to conventional air turbines due to their ability to maintain stable efficiency across a wide range of flow coefficients. While prior evaluations have demonstrated their promising performance under steady and bidirectional flows, understanding their behaviour under realistic ocean environments remains essential. This study employs computational fluid dynamics to examine CFAT performance in irregular wave conditions, replicating sea states through airflow profiles generated from the JONSWAP spectrum. The simulations, conducted at a constant turbine speed of 700 rpm, incorporated two significant wave heights (1.25 m and 1.75 m) and two peak wave periods (5.25 s and 6.75 s), with the k-omega shear stress transport model applied to resolve internal turbine flow dynamics. The results reveal that torque output is sensitive to variations in wave-induced airflow, with larger wave heights producing pronounced fluctuations and periods of negative torque associated with flow reversal. These outcomes highlight the transient nature of energy capture in irregular seas and demonstrate the necessity of accounting for such unsteady effects in turbine design and optimization. Overall, the findings provide valuable insights into the operational dynamics of CFATs in real-world conditions, contributing to the advancement of reliable and efficient wave energy conversion technologies.

Keywords: Computational Fluid Dynamics; Crossflow Air Turbine; Oscillating Water Columns; Power Take-off Systems; Renewable Energy; Wave Energy

ICSBE25_330

ASSESSING ROOFTOP SOLAR PV POTENTIAL AND SUITABILITY THROUGH INTEGRATED SPATIAL ANALYSIS IN TRINCOMALEE DISTRICT, SRI LANKA

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Abstract: Rooftop Solar Photovoltaic (PV) systems offer a decentralised and practical solution to meet growing energy demands while mitigating carbon emissions. In Sri Lanka, building-level planning remains underexplored, although it possesses high solar potential. Due to the population overgrowth and industrial expansion, the Trincomalee district is currently experiencing rising energy requirements. This study presents a framework that integrates Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis (MCDA) through Analytic Hierarchy Process (AHP) for assessing rooftop solar PV suitability and potential to support data-driven renewable energy planning. Eight key factors from the spatial and environmental criteria were selected, reclassified, and weighted through the AHP with a CR of 1.4% to generate a rooftop solar suitability. Solar irradiance was modelled using a 12.5 m resolution DEM, and building footprints were extracted from OpenStreetMap and filtered based on rooftop size and suitability value to identify the optimal sites for PV installation. As a result, 32,511 buildings were identified as suitable for rooftop solar PV out of over 100,000 buildings. From the selected buildings, it is estimated that the mean effective energy production is 10,496 kWh per building, with the total energy potential of 341.24 GWh annually. This saves approximately 215 kilotonnes of CO_2 emissions. Divisional Secretariat (DS) level analysis identified Kantale and Trincomalee Town & Gravets are the most promising divisions for solar PV deployment. Although this method provides accurate results, it didn't consider some relevant factors such as roof obstructions, technical factors for panel efficiency, and economic feasibility. Further improvements should include the use of high-resolution DSM data, shadow modelling, and cost-benefit analysis to enhance implementation potential. Using open-source data and GIS tools, this study offers a scalable and replicable approach to assist solar energy planning in Sri Lanka. It supports the national goal of achieving 70% clean electricity by 2030, enhancing sustainable urban development and long-term climate resilience.

Keywords: Analytical Hierarchy Process (AHP); Geographic Information System (GIS); Multi-Criteria Decision Analysis (MCDA); Renewable Energy Planning; Spatial Decision Support; Sustainable Energy Transition

ICSBE25_390

EXPERIMENTAL STUDY ON THE EFFECT OF BOTTLE GEOMETRY AND CHEMICAL COMPOSITION ON LIGHT INTENSITY IN SOLAR BOTTLE LAMPS

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Abstract: Solar Bottle Lamps are an affordable and sustainable lighting solution that repurposes discarded plastic bottles while harnessing solar energy. However, their performance largely depends on both the physical structure of the bottle and the internal medium that alters light refraction. This study experimentally investigates two critical parameters influencing illumination: bottle shape and chemical additives inside the bottle. In the first stage, five different bottles (Sprite, Pepsi, Aquafina, and two generic water bottles) were tested under identical lighting conditions using a lux meter. Results indicated that the Sprite bottle (B1) provided the highest light intensity, highlighting the significant role of bottle geometry in refraction and distribution. In the second stage, the optimal bottle (B1) was filled with solutions containing varying concentrations (10 g, 30 g,50 g, 70 g, 90 g) of five different chemicals: sugar ($C_{12}H_{22}O_{11}$), salt (NaCl), calcium chloride ($CaCl_2$), potassium hydrogen phosphate (K_2HPO_4), and chlorine-based solution. Among these, sodium chloride (NaCl) at 70 g concentration produced the brightest emission, reaching ~4602 lux, outperforming all other tested chemicals and ratios. The findings suggest that the combination of bottle geometry and specific chemical composition can significantly enhance the brightness of Solar Bottle Lamps. This insight contributes to the development of low-cost, environmentally friendly lighting alternatives, especially in underprivileged communities with limited access to electricity. Further optimization with broader bottle designs and chemical combinations can potentially improve scalability and adoption. To ensure accuracy, all experiments were repeated at different time zones of the day, and the final results were obtained by averaging the recorded values

Keywords: Bottle Geometry; Chemical Composition; Light Refraction; Solar Bottle Lamp; Sustainable Lighting

ICSBE25_417

FROM ROADMAP TO REALITY: ENGINEERING AND POLICY PRIORITIES FOR SRI LANKA'S HYDROGEN ECONOMY

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Abstract: Sri Lanka's National Hydrogen Roadmap (2023) outlines a strategy to incorporate green hydrogen into the national energy framework and establish the nation as a regional supplier by 2035. Despite its ambition, the roadmap remains largely conceptual, with insufficient detail on the engineering and policy mechanisms required for implementation. This study fills this gap by moving the conversation from roadmap to reality by identifying realistic engineering goals and policy initiatives that can turn Sri Lanka's aspirations for hydrogen into tangible results in three crucial areas. First, the study assesses the viability of three primary hydrogen storage vectors: compressed gas, liquid hydrogen, and ammonia, over their energy density, infrastructural needs, and compatibility with Sri Lanka's geographical and industrial contexts. Second, it investigates end-use applications using quantified scenarios in transportation, industrial decarbonisation, and electrical grid stabilisation. Third, it evaluates a country's ability to function as a regional hydrogen hub by mapping port infrastructure and marine trade routes, highlighting opportunities for an export industry. As emerging solutions, four policy priorities are identified in the study: (i) setting clear targets and cost benchmarks for hydrogen production; (ii) developing financial mechanisms to draw in foreign direct investment; (iii) creating export standards, certification procedures, and safety frameworks that are in line with global markets; and (iv) integrating hydrogen technologies into academic programs and vocational training to build a specialised workforce. Through the integration of these measures with technical imperatives, the study outlines a phased pathway to 2035, starting with pilot projects and progressing through infrastructure development and export readiness. The findings further emphasise that without timely progress on storage, end-use pilots, and regulation, Sri Lanka risks falling behind regional competitors. With decisive implementation, however, the country can leverage its renewable potential and strategic location to establish itself as a reliable performer in the global hydrogen economy.

Keywords: Engineering Feasibility; Green Hydrogen; Hydrogen Storage; Policy Priorities

ICSBE25_432

OPTIMIZATION OF BIOMASS BRIQUETTES PRODUCED FROM ALGAE AND WATER HYACINTH FOR SUSTAINABLE ALTERNATIVE FUEL PRODUCTION IN SRI LANKA

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Abstract: Sri Lanka struggles to secure sustainable energy due to overdependence on fossil fuels as the main commercial energy supply source. Although algae and water hyacinth are highly abundant and can be converted into renewable energy, they remain underutilized. This study focuses on producing and improving biomass briquettes made from microalgae, macroalgae, and water hyacinth as a sustainable and alternative fuel. The approach included collecting biomass from local water bodies, using both solar and oven drying methods, and carbonizing a portion of the biomass samples. Briquettes were made under varying pressures with a universal testing machine. The briquettes were assessed based on mechanical stability, Gross Calorific Value (GCV), ash and moisture contents, energy input and energy density. After the briquettes were made, the most optimal briquette conditions were chosen out of 15 trials, by using the response surface model generated using the Minitab tool and thereby the optimal pressure and the mixing ratio were determined. Results revealed that microalgae exhibited a comparatively higher ash-free gross calorific value (18.2 MJ/kg) but poor mechanical stability, whereas water hyacinth showed a lower GCV of 16.7 MJ/kg with superior mechanical stability. In contrast, the combined briquettes demonstrated enhanced overall fuel characteristics, as indicated by the response surface model. These findings confirm that briquettes produced from mixed biomasses using POMS as a binder have strong potential to be utilized as sustainable alternative fuels. The study emphasizes their potential as effective industrial fuels, contributing to sustainable waste-to-energy solutions and supporting a circular economy in Sri Lanka.

Keywords: Algae to Fuel; Circular Bioeconomy; Energy from Aquatic Plants; Renewable Energy; Solid Biofuel; Waste to Energy

ICSBE25_517

DESIGN OF A SOLAR-AIR HEAT COLLECTOR FOR A SPICE DRYING TRAY DRYER

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Abstract: In Sri Lanka, spices are a significant agricultural product, and post-harvest drying greatly affects their quality. Traditional techniques like open-sun drying and electrical dryers have drawbacks, including contamination, excessive energy consumption, and uneven heating. The necessity for a hybrid drying method that is both economical and effective for small-scale farmers is addressed in this study. The aim of this study is to develop and assess a solar-air heat collector that can be connected to an electrical tray dryer in order to improve efficiency and reduce energy consumption. In Sri Lanka, solar energy is a reliable renewable resource that lessens the reliance on electricity and fossil fuels. Prior research indicates that hybrid drying systems with solar assistance can greatly increase energy efficiency without sacrificing product quality. Additionally, research indicates that the best collector type to use with an electrical dryer for small-scale spice drying is a flat plate solar collector. In order to establish baseline performance first, an electrical tray dryer was designed and fabricated. Its design features regulated heating and forced-air circulation to keep uniform drying conditions. During the collector design process, calculations were made to establish the necessary heat gain so that the simulations could confirm it. Simulations were performed to model the collector in TRNSYS with meteorological year data, followed by SolidWorks flow simulation for airflow path and shape design selection for the absorber plate. The calculated power requirement for selected spice drying is 0.25 kW, while the solar collector simulation indicates a higher power output, delivering 0.27 kW as an annual average. The results confirm the feasibility of combining the solar collector with an electrical tray dryer for small-scale spice drying. This suggests that the collector can provide sufficient heated air to support spice drying reliably throughout the year in the climatic conditions of Sri Lanka.

Keywords: Drying Efficiency; Electrical Dryer; Hybrid System; Renewable Energy; Solar Collector; Spice Dryer

ICSBE25_530

SALT STRESS IMPACTS ON BIOMASS PRODUCTION IN *Chlorella sp.*

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Abstract: Salinity is one of the important abiotic stresses that can affect microalgal growth, metabolism, and biochemical composition. This study was conducted to evaluate the impact of three different salts, such as NaCl, Sea salt, and $CaCl_2$, on *Chlorella sp.* growth in terms of cellular biomass. The aim is to understand how different ion levels affect growth performance and to identify appropriate salt types for their utilization. The microalgae samples were cultivated in Bold's Basal Medium (BBM) with six salt concentrations ranging from 0 to 0.5 M. The culture was conducted in a 25 °C temperature and controlled photoperiod (12:12 h light-dark cycles) and 10,000 lux. The salts were added in the stationary phase with natural stresses for efficient metabolite formation. Growth performance was evaluated through Optical Density (OD) readings at 680 nm wavelength and weight determination by filtering the sample through the 1.2 µm Glass Fiber filters. According to the experimental results, it is clear that *Chlorella sp.* can easily adapt to all tested samples with considerable growth performance. Indeed, $CaCl_2$ showed higher growth performance with 8.41 g/L compared to both NaCl and Sea salt with 0.5 M concentration due to the balanced ion types beneficial for utilization. However, there is little difference between all samples because the tested microalgal species maintained homeostasis regardless of the tested samples. These experimental observations clearly identify and confirm *Chlorella sp.* species' high capability for adapting to high salinity. These observations demonstrate growth performance for microalgae cultivation even with small aquatic freshwater resources. These experimental outcomes properly facilitate sustainable growth for *Chlorella sp.*'s on-site cultivation in saline areas where freshwater is constrained. The growth performance demonstrated in this experimental work clarifies microalgae's utilization for low-cost sustainable growth. This experimental work is useful for designing efficient growth strategies for sustainable biofuel plantations.

Keywords: Biomass Production; $CaCl_2$; *Chlorella sp.*; NaCl; Salinity; Sea Salt

ICSBE25_571

DEVELOPING AN ADAPTIVE UNDER FREQUENCY LOAD SHEDDING SCHEME FOR SRI LANKA UNDER HIGH PENETRATION OF INTERMITTENT RENEWABLES: A SYSTEMATIC REVIEW

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Abstract: Sri Lanka’s power system faces increasing frequency stability challenges as system inertia declines and renewable generation expands, leading to faster Rates of Change of Frequency (ROCOF) and deeper minimum frequency dips following disturbances. This systematic review, conducted under the referred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) framework, analyses peer reviewed articles (2005 - 2024) retrieved from Scopus and Web of Science, categorized into three domains conventional Under Frequency Load Shedding (UFLS) Methods, Adaptive (Dynamic/Analytical) Schemes, and Computational Intelligence & AI-Based Approaches to develop an adaptive under frequency load shedding scheme tailored to Sri Lanka’s operating conditions. The findings indicate a predominant focus on conventional multi-stage UFLS, which relies on fixed frequency thresholds and preset load blocks typically tuned through off-line studies. While simple and robust, these schemes often suffer from over-shedding and delayed recovery under low inertia conditions. In contrast, adaptive schemes enhance responsiveness by integrating analytical swing equation models, ROCOF-based dynamic thresholds, wide area phasor measurements, and voltage stability indicators, together with optimization-based real-time control frameworks such as linear programming, sensitivity analysis, and model predictive adjustment, enabling precise estimation of power imbalance and more proportionate, event-sensitive load shedding. Recent advances show a marked transition toward AI-driven and computational intelligence methods, employing Artificial Neural Networks (ANNs), fuzzy inference systems, neuro evolution, deep learning, and reinforcement learning to predict system behaviour and optimize shedding decisions. Hybrid frequency voltage and risk-aware decentralized frameworks further enhance resilience in microgrid and renewable-dominant environments. The emerging trend underscores an evolution from static threshold-based logic to adaptive, data-driven, and coordinated UFLS architectures capable of maintaining stability in low-inertia, high renewable power systems. Building on this foundation, the review consolidates current progress and proposes a centralized adaptive under-frequency controller that continuously tracks load, topology, and resource variability to enable timely and proportional shedding decisions tailored to Sri Lanka’s grid.

Keywords: Adaptive Load Shedding; Artificial Intelligence; Islanding Operations; Power System Stability; Rate of Change of Frequency; Under Frequency Load Shedding

ICSBE25_656

THERMAL-DRIVEN MECHANICAL SOLAR TRACKER FOR SUSTAINABLE ENERGY HARVESTING IN BUILT ENVIRONMENTS

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Abstract: The present work introduces a new type of completely passive solar tracking mechanism, driven by thermal expansion principles with no external electrical input. The system incorporates a parabolic solar collector with an evacuated glass tube containing microcrystalline wax serving as the thermal actuator. Concentrated sunlight heats the wax, and the volumetric expansion pushes on a piston to compress a spring. This mechanical motion is translated through a cam arrangement, allowing the solar panel to maintain an optimal orientation with the sun throughout the day. When the temperature drops at sunset, the wax contracts, releasing the piston and returning the system to its initial state, thus ensuring complete automation on a daily basis. The proposed design differs from the conventional motor-based and sensor-controlled trackers in that no power consumption or electronic control is involved. Further, the simple mechanical configuration increases durability and lowers maintenance, hence making it suitable for remote and off-grid environments with energy efficiency at a premium. Preliminary studies and trials of prototypes showed that effective sun-tracking precision exists in the system, along with higher capture of solar energy compared to fixed-panel setups. This system will merge sustainable design with passive thermal control to provide a self-sustaining, low-cost solution for renewable energy harvesting. In this respect, it becomes another step toward eco-friendly engineering since the enhancement of photovoltaic efficiency and a decrease in dependence on conventional energy inputs support global pursuits for sustainable and resilient energy technologies.

Keywords: Microcrystalline Wax; Parabolic Collector; Passive Solar Tracking; Renewable Energy System; Sustainable Photovoltaic Design; Thermal Expansion Actuator

INNOVATIONS IN PROTECTIVE STRUCTURE DESIGN FOR RESILIENT COMMUNITIES

ICSBE25_050

PERFORMANCE-BASED DESIGN OF STIFFENED EXTENDED END PLATE BEAM TO COLUMN CONNECTION

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Abstract: After the 1994 Northridge earthquake and the 1995 Kobe earthquake, it was identified that fully welded rigid connections were subjected to severe cracking. As a solution to that problem, alternative connection methods were developed, as presented in the literature review. An extended end plate was introduced to overcome the cracking problem in a fully welded rigid connection, and also, the extended end plate increased the lever arm; hence, more moment resisting capacity could be achieved. But in an extended end plate connection, when yielding of the end plate happened at the tension region, it created an extra tension force on the bolts of the tension region. To prevent this, a stiffened extended end plate was introduced. By using a stiffener at the tension region, the moment capacity of the connection was increased, and the stability of the connection was also increased. However, there are not many methods to design a stiffened extended end plate beam-to-column connection. Even though there are some methods, they only ensure the strength of the design, but the ductility is not considered. Generally, a performance-based method has special benefits over other usual methods that are in use. By using this method for designing a stiffened extended end plate beam to column connection, it can be certainly identified that the first failure that will happen, and the order of the failures that can occur. To validate this method, numerical simulations are conducted by using three models. First and second models were used to compare the effect of stiffeners, and the second and third models were used to compare the ranking system, which was assigned with poor and preferred failure modes in order. It was concluded that using stiffeners connecting the beam flange and end plate stabilized the connection even more, and the moment resistance capacity was higher than the moment resistance capacity of connections without stiffeners.

Keywords: Beam-to-column Connection; Performance-based Design; Steel Connection; Stiffened Extended End Plate Connection

ICSBE25_339

NUMERICAL MODELING OF CLOSED-IN BLAST EFFECTS ON REINFORCED CONCRETE STRUCTURES USING AN SPH-ALE COUPLING APPROACH

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Abstract: Reinforced Concrete (RC) structures are extensively used in civil infrastructure due to their durability and load-bearing capacity, yet they remain highly vulnerable to blast loads from accidental or deliberate explosions. Accurate numerical simulation of blast effects is essential for designing blast-resistant structures and understanding failure mechanisms. Conventional numerical methods often fail to capture the extreme deformations, high strain rates, and rapid energy transfer associated with near-field explosions, while mesh-based approaches can suffer from severe distortion. The Smoothed Particle Hydrodynamics (SPH) method available in the non-linear finite element software LS-DYNA is a mesh-free modelling technique, which offers advantages that are particularly useful in capturing large deformations near the explosion source. However, its accuracy tends to decrease significantly as the stand-off distance increases, limiting its effectiveness in capturing blast wave propagation in the air domain. To address this limitation, a coupled SPH–Arbitrary Lagrangian-Eulerian (ALE) approach is proposed, where SPH models the explosive charge and ALE captures shockwave propagation in the surrounding air. Following an experimental study in the published literature, the present study investigates the response of a 40 mm-thick, 1000 mm × 1000 mm RC slab panel under near-field blast loading at a scaled distance of 0.68 m/kg$^{1/3}$, employing a quarter model to exploit symmetry and reduce computational cost. A comprehensive mesh convergence study and parametric sensitivity analysis were conducted by varying key SPH parameters, including the time step scale (TSSFAC), constraint force scale (SOFSCL), and smoothing length scale (CSLH). Validation against experimental data demonstrates that the SPH–ALE approach provides improved numerical stability, reduced mesh distortion, and more accurate deflection-time histories compared to conventional methods. The findings establish a systematic procedure for selecting SPH parameters and highlight the potential of the SPH–ALE method for practical blast simulation applications in reinforced concrete structures.

Keywords: ALE method; Concrete Structures; Near-field Blasts; SPH Method

ICSBE25_403

DEVELOPMENT OF A SILANE-BASED CHEMICAL ADHESIVE SYSTEM FOR ENHANCED RUBBER-TO-METAL BONDING IN INDUSTRIAL APPLICATIONS

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Abstract: Rubber-to-metal bonding is critical in many high-performance engineering applications, yet achieving durable, corrosion-resistant adhesion remains a challenge. Most of the conventional adhesive systems for this purpose are petroleum-based, and they emit harmful volatile organic compounds. This study focuses on developing a Novel silane-based chemical adhesive system using Vinyl Triethoxy Silane (VTES) to enhance the bonding performance between Natural Rubber (NR) and metal. This system provides insights to develop a sustainable alternative path by eliminating conventional petroleum-based adhesive systems. This approach involved hydrolyzing VTES, which can form covalent Si–O–Metal bonds with surface oxides on mild steel and stainless steel. At the same time, its vinyl functionality enables participation in the sulfur vulcanization of NR, thus creating strong interfacial chemical linkages. Further, this research investigates the effect of varying sulfur content in a rubber Conventional Vulcanization (CV) system while keeping the sulfur-to-accelerator ratio constant. the surface chemistry of the modified steel substrates were characterized using Fourier-transform Infrared Spectroscopy (FTIR). Contact angle measurements were used to assess surface wettability and coating uniformity. Adhesion performance was evaluated using the ASTM D1002 lap shear test. Results showed that lower sulfur phr levels resulted in higher lap shear strength, highlighting the role of sulfur optimization for metal bonding. FTIR confirmed the hydrolysis of VTES and formation of Si–O–Metal bond, while contact angle data demonstrated improved hydrophobicity and surface uniformity. The optimized adhesive formulation yielded a robust, corrosion-resistant bond with superior mechanical stability, an essential requirement for automotive, aerospace, and heavy-duty industrial components. This work concludes that VTES-based silane coatings, coupled with controlled vulcanization conditions, offer an effective pathway for designing next-generation adhesive systems. The study provides valuable insights into creating efficient, reliable, and environmentally resilient rubber-to-metal assemblies.

Keywords: Corrosion Resistance; Lap Shear Strength; Rubber-to-metal Adhesion; Silane Coupling; Sulfur Optimization; Vinyl Triethoxy Silane

ICSBE25_585

MID-SPAN DEFLECTION TIME HISTORY PREDICTION OF HOLLOW STEEL BEAMS UNDER LOW-VELOCITY IMPACT USING DEEP NEURAL NETWORK

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Abstract: The dynamic behaviour of hollow steel beams subjected to low-velocity transverse impact was investigated using a finite element and machine learning approach. A numerical model of a 120 × 80 × 3 mm S275JR steel hollow section beam with a span of 3 m was first developed and validated. A 75 kg impactor was released from eight drop heights ranging from 250 mm to 2000 mm under simply supported boundary conditions. The numerical model with Johnson-Cook material modelling was validated through comparisons of mid-span deflection time histories across all impact scenarios. Following validation, a comprehensive parametric study was performed by varying the support conditions (simply supported and fixed), material properties, and beam thicknesses. The resulting mid- span deflection time histories were analysed to evaluate the influence of each parameter on the structural response under transverse impact. The dataset generated from the parametric study was subsequently used to train a Deep Neural Network (DNN) for predicting mid-span deflection time histories. The trained model achieved high predictive accuracy, with Coefficient of determination (R^2) values of 0.992 and 0.993 and Root Mean Square Error (RMSE) values of 0.86 mm and 0.88 mm for the training and testing datasets, respectively. The findings demonstrate that the DNN model can reliably predict the dynamic response of hollow steel beams under varying impact conditions, highlighting its potential as complementary fast running tool.

Keywords: Deep Neural Network; Hollow Steel Beams; Low-velocity Impact; Mid-Span Deflection; Thin-walled Sections

ICSBE25_587

FAILURE ANALYSIS OF TEMPORARY SCAFFOLDING STRUCTURES UNDER WIND LOADS: A CASE STUDY

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Abstract: Scaffolding is a temporary structure serving a primary purpose of allowing construction workers to safely carry materials and conduct their tasks at an elevated height. It is an essential safety measure that ensures stability and permits access to areas that are otherwise difficult to reach. A well-designed scaffolding system should include and prioritize structural safety, a stable foundation, proper load distribution and the ability to withstand various environmental conditions. The paper presents the details of a site inspection conducted on May 30th, 2025, to investigate the partial collapse of a temporary supporting scaffolding at the Office Building in Colombo, Sri Lanka, that occurred the day prior. It was observed that the collapse happened on one side of the building from Level 4 to Level 6 due to the high wind pressures. During the site investigation, it was determined there were numerous other underlying issues that contributed to the breakdown of the momentary structure. This included the excessive unsupported height above the top level of construction that led to a critically unbalanced upper segment. In addition, the connections between the structures and scaffoldings were found to be insufficient and extremely weak, leading to increased displacement in response to wind-generated forces. Further, the use of dust netting in place of structural safety nets created a lateral drag effect, catalysing the instability that ultimately caused the downfall. The study discusses recommended solutions to successfully prevent the recurrence of structural failures after thoroughly scanning and analysing improper operation of equipment and external factors.

Keywords: Construction Safety; Failure Investigation; Load Distribution; Preventive Measures; Scaffolding Collapse; Structural Instability; Temporary Structures; Wind Load Effects

NEXT-GENERATION BUILDING MATERIALS FOR SUSTAINABLE AND RESILIENT CONSTRUCTION

ICSBE25_037

CHALLENGES AND OPPORTUNITIES IN INTEGRATING RAW - EARTH 3D PRINTING WITH TRADITIONAL EARTH CONSTRUCTION IN SRI LANKA

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Abstract: Climate change is a major global concern, causing irreversible damage to ecosystems, including coastal and marine environments, and altering seasonal patterns. Urban areas, though occupying only 3% of the Earth's land, produce over 75% of carbon emissions, with the building sector contributing significantly to 30% of global emissions, 40% of energy use, and 25% of water consumption. In Sri Lanka, the construction sector intensifies these impacts due to inefficient design and high energy use. To address these challenges, Raw-Earth 3D Printing (3DEP) is emerging as a sustainable alternative, offering improved efficiency, reduced material waste, and lower environmental and labour impacts. From a stakeholder perspective, this study presents a literature review to evaluate the potential integration of 3DEP into Sri Lanka's construction landscape. A total of 45 peer-reviewed articles and technical reports published between 2015 and 2023 were reviewed using a qualitative synthesis approach. The review focuses on two key areas: (1) global advancements in additive manufacturing using earthen materials, and (2) traditional raw earth construction practices in Sri Lanka. The findings reveal both challenges and opportunities, highlighting the possibility of integrating 3DEP technology with Sri Lanka's raw earth construction, along with providing recommendations for future developments in this field in Sri Lanka. Therefore, Key challenges include the lack of local standards, limited technical knowledge, material consistency issues, and the absence of regulatory frameworks for Raw-Earth 3D printing. However, significant opportunities lie in Sri Lanka's existing familiarity with earth-based materials, the growing need for low-carbon construction, and increasing stakeholder interest in sustainable technologies. The study concludes by proposing a set of recommendations to facilitate the integration of 3DEP with Sri Lanka's raw earth building heritage and encourages future research and policy development in this field.

Keywords: 3DEP; Climate Change; Earth Construction; Low-carbon Built Environment; SDG 9

ICSBE25_041

PERFORMANCE EVALUATION OF BANANA STEM FIBERS PRETREATED BY ALKALINE HYDROGEN PEROXIDE PRETREATMENT

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Abstract: Cellulose fibers play a main role as sustainable reinforcing agents in composite materials. As a naturally occurring long-chain polymer derived from lignocellulosic sources, cellulose offers excellent mechanical properties, making it an ideal candidate for developing eco-friendly structural materials. In this study, Alkaline Hydrogen Peroxide (AHP) pretreatment was used to extract cellulose from banana stem, a widely available lignocellulose material in Sri Lanka. Three pre-treatment solutions were made by mixing three different amounts of NaOH with the same volume (10 ml) and the same small amount (0.5 ml) of hydrogen peroxide (H_2O_2). The experiment consists of 9 sample combinations (banana steam treated with C1, C2, and C3) and replicating each three times. After AHP pretreatment, the percentage of weight loss, percentage of cellulose content, fiber diameter, tensile strength, and morphological characteristics were tested. Additionally, Fourier Transform Infrared Spectroscopy (FTIR) was done for the confirmation of extracted fibers. Holocellulose content and weight loss percentage were 86.63% - 88.97% and 64.84% - 74.32%, respectively, in pretreated fibers. The tensile strength varied, and the fiber diameter was between 134.0 and 238.0 µm. According to the test results, the optimum C3 pre-treatment solution concentration for banana stem was selected based on maximizing holocellulose content and acceptable fiber properties.

Keywords: Alkaline Hydrogen Peroxide; Banana Stem; Lignocellosis Materials; Pretreatment

ICSBE25_285

NUMERICAL ANALYSIS ON FLEXURAL BEHAVIOUR OF COMPOSITE HEMPCRETE TEXTILE REINFORCED CONCRETE

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Abstract: This study presents a comprehensive numerical investigation on the flexural behavior of Hempcrete Textile Reinforced Concrete (HTRC) and develops a detailed material model for Finite Element Modeling (FEM) applications. The work is motivated by the well-recognized drawbacks of conventional steel reinforcement, including its susceptibility to corrosion in aggressive environments, large self-weight, and the requirement for thick concrete covers to ensure durability. These issues increase construction costs, maintenance needs, and environmental impact over a structure's life cycle. Textile Reinforced Concrete (TRC) has emerged as a promising alternative due to its lightweight nature, non-corrosive properties, and capacity to form slender structural elements with reduced material usage. However, because TRC does not require a protective clear cover, its reduced thickness results in higher thermal conductivity, which can compromise thermal comfort when used in façade or wall elements. To address this limitation, hempcrete, a natural, lightweight, thermally insulating, and carbon-sequestering material, has been integrated with TRC, creating the HTRC composite. This combination aims to maintain TRC's mechanical advantages while significantly improving thermal insulation and sustainability. In this study, a detailed numerical model of HTRC beams was developed. The model was calibrated and validated against previously done experimental results, successfully replicating flexural response and post-cracking behavior. This study provides a robust modeling framework that can guide future HTRC design and optimization. This research contributes to the growing body of knowledge on sustainable composites, offering a pathway toward lighter, longer-lasting, and more environmentally responsible construction systems.

Keywords: Concrete Damage Plasticity (CDP); Finite Element Analysis (FEA); Flexural Behaviour; Hempcrete Textile Reinforced Concrete (HTRC); Sustainable Composite Materials

ICSBE25_371

TRACKING THE FLOW: A QUANTITATIVE ANALYSIS OF SAND PRODUCTION AND PRICES IN SRI LANKA (2020-2024)

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Abstract: Sand is one of the most extracted natural resources worldwide, but its availability is increasingly limited by high demand. In Sri Lanka, rapid urbanization and construction have increased extraction from rivers, floodplains, and inland deposits, causing environmental and socio-economic impacts. This quantitative study analyzes sand production and prices between 2020 and 2024 using official data from the Geological Survey and Mines Bureau. Results show that river sand, which accounted for about 70% of the total supply in 2020 - 2021, declined to 66% by 2024 due to resource depletion and stricter regulations, while process sand increased from 12% to 16–17%, indicating its potential as a sustainable alternative. Inland sand declined from 23% in 2021 to 18% in 2024, and sea sand remained negligible (0 - 1%) due to chemical and technical limitations. Price analysis revealed a sharp increase from LKR 8,000 in 2020 - 2021 to nearly LKR 15,000 in 2022, stabilizing at this higher level through 2024, reflecting post-pandemic demand and supply constraints. Regionally, the Eastern Province led production, followed by North Central and Uva, reflecting sediment-rich river systems, while mountainous or urbanized provinces showed lower outputs. These findings provide evidence-based insights for policymaking and environmental planning, emphasizing the need to regulate extraction in high-production areas, promote sustainable substitutes like process sand, and manage market dynamics to balance construction demand with ecological sustainability.

Keywords: Price Trends; Production Analysis; Regional Distribution; Resource Sustainability; Sand Mining; Sri Lanka

ICSBE25_384

ASSESING THE ENVIRONMENTAL BENEFITS OF REPURPOSING TUNNEL MUCK AS A GREEN CONSTRUCTION MATERIAL

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Abstract: This study explored the potential of converting tunnel muck, excavation waste, and construction debris into sustainable building materials. Tunnel muck from the Habarana-Anuradhapura Tunnel Project in Sri Lanka was analyzed. A three-stage program was conducted to assess its suitability for making blocks and for geotechnical uses in road construction. In the first stage, individual laboratory tests determined the physical, chemical, and mechanical properties of the tunnel muck. These included routine analyses such as sieve analysis, sulphate and chloride content, and alkali-silica reactivity. The results showed that, when handled properly, the material meets the required construction standards. The second stage examined possible applications. Tunnelling muck was initially utilized to produce concrete blocks by replacing traditional sand and aggregates with different mix ratios. These were tested for strength, absorption, and durability, with some mixes achieving compressive strengths of up to 6.81 MPa. Additionally, the material was evaluated for potential use in road construction. Key engineering tests, including Aggregate Impact Value (AIV), Flakiness Index, Proctor Compaction, and California Bearing Ratio (CBR), confirmed that tunnel muck is a suitable fill material for sub-base and subgrade layers. The third stage involved large-scale sustainability assessments. A Life Cycle Analysis (LCA) demonstrated that reusing tunnel muck considerably reduces environmental impacts, including carbon footprints and resource consumption. The cost-effectiveness analysis indicated that tunnel muck compaction can lower material costs by over 80%. Surveys of public opinion also revealed widespread local support for employing construction materials derived from tunnel muck. Overall, the study presents tunnel muck as an environmentally sustainable and eco-friendly building material for structural and infrastructure uses. Its circular economic approach aligns with sustainable development principles.

Keywords: Carbon Footprints; Circular Economy; Compressive Strength; Eco-friendly Building Material; Sustainable Materials

ICSBE25_389

INNOVATIVE MODULAR STEEL CONNECTION TECHNOLOGIES FOR MODULAR CONSTRUCTION: A REVIEW OF STRUCTURAL EFFICIENCY AND PERFORMANCE

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Abstract: This research addresses the fundamental conflict in volumetric modular construction between the need for rapid on-site assembly and the demand for high seismic resilience in inter-module steel connections. The problem is that traditional rigid connections fail catastrophically under seismic loads, while high-performance solutions often sacrifice the modular benefits of speed and low cost. The approach involved a comparative technical review and scoring matrix evaluating five advanced connection types: Post-Tensioned (PT) Rod Assemblies, Shape Memory Alloy (SMA) Connections, Self-Locking/Plug-in Systems, Friction-Damped (FD) Connections, and Conventional/Hybrid Assemblies. The evaluation was based on seven criteria, including Seismic Resilience (measured by residual drift, δres), Constructability, and Cost Impact. The solution involves strategically selecting a connection based on project-specific risk tolerance. Key findings confirm that high-resilience systems (PT and SMA) guarantee zero or near-zero residual drift by utilizing non-damaging, self-centering mechanisms, but incur the highest costs and require complex field calibration. Conversely, Self-Locking Systems achieve superior Constructability and Reusability, offering the optimal economic solution for speed-driven projects. The principal conclusion is that the ideal choice is a risk-reward optimization; no single system provides universal superiority. The overall impact of this work is to establish a clear framework to guide engineers in selecting connection technologies that balance initial capital investment against long-term operational resilience and schedule efficiency.

Keywords: Modular Construction; Residual Drift; Risk-reward Optimization; Seismic Resilience; Self-centering

ICSBE25_521

INFLUENCE OF FIRING TEMPERATURE ON PHYSICAL, MECHANICAL, AND MINERALOGICAL PROPERTIES OF CLAY BRICKS: A CASE STUDY FROM BIYAGAMA, SRI LANKA

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Abstract: Contemporary burnt clay brick production in Sri Lanka is characterized by inconsistencies in raw material selection and the strength of the bricks. Therefore, a systematic scientific approach is essential to optimize current practices. Biyagama is recognized for its long-standing tradition in the clay industry. Thus, this research investigates the impact of firing temperature, moisture content, and mineralogical properties on the physical and mechanical properties of clay bricks produced in Biyagama, Sri Lanka. Raw clay samples were collected from Biyagama used to fabricate 96 bricks with varying moisture contents. These samples were fired at four temperatures: 300 °C, 600 °C, 900 °C, and 1200 °C. Comprehensive analyses were conducted using standard methods, including wet and dry compressive strength testing, water absorption, particle size distribution, plasticity index, colour analysis, X-ray Diffraction and Scanning Electron Microscopy (SEM). The results indicated that with increasing temperature, the compressive strength increased, reaching 7.59 MPa at 900 °C and 15.43 MPa (wet) and 18 MPa (dry) at 1200 °C, while water absorption decreased to 12.6 %. The optimum moisture content is identified as 20 – 22 %, which produced high-strength bricks. The particle size distribution, which exhibits over 80% of fine particles (< 0.1 mm) are significantly contributes to improving the strength. The raw clay exhibited a plasticity index of 8.73(medium plasticity), clay suitable for brick making. Colour analysis revealed that progressive darkening occurs with an increase in temperature. The mineralogical transformations from kaolinite to mullite at 1200 °C demonstrated the reason for strength enhancement. Further, morphological analysis revealed the formation of dense, interconnected pore structures that contributed to reduced porosity and enhanced mechanical strength. Overall, the study emphasized that controlling moisture content, firing temperature, and particle size is essential to optimize the quality of Biyagama clay bricks for sustainable brick production.

Keywords: Clay Bricks; Compressive Strength; Firing Temperature; Mineral Formation; Morphology

INTEGRATING GREEN INFRASTRUCTURE, BIODIVERSITY, AND BIOPHILIC DESIGN FOR SUSTAINABLE URBAN WELL-BEING

ICSBE25_017

POTENTIAL OF URBAN GREENERY INTEGRATION FOR MITIGATING TRAFFIC-INDUCED AIR POLLUTION IN SRI LANKA

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Abstract: Traffic emissions are one of the most severe environmental and human health concerns in Sri Lanka's major cities due to population expansion and automobile use. Passive solutions using green infrastructure and urban vegetation are effective for the mitigation of air pollution because of their natural air-purifying property. Green interventions are reviewed, and the air quality improvements are critically assessed to assess their potential for mitigating the most acute forms of urban air pollution. The literature in the review covers from 2010 to 2024 and it was gathered from various databases: Google Scholar, ScienceDirect and Research Gate. Studies evaluate the roles of green roofs, green walls, vegetative barriers, green belts, hedgerows, and green spaces in reducing traffic-related air pollution in urban environments. Trees in street canyons trap pollutants when airflow is restricted and trees along the sidewalk block and reduce the spread, especially when combined with emission control measures. Unlike trees and hedgerows, green walls and roofs are less effective at improving air quality because pollutant deposition is difficult in well-ventilated areas. Reviewed studies have shown that vegetation belts reduce air pollution by 16%, control dust and smoke by 72%. The review discusses the possibility of applying green infrastructure to the urbanized land, with the issues to be considered including high retrofit cost, the absence of standardized guidelines, adaptation and maintenance requirements, space availability in dense urban environments, and insufficient community participation. Smart sensors integrated into urban vegetation are recommended to monitor real-time pollution levels, and dispersion deposition modelling should be used to optimize future green infrastructure air pollutant reductions. Green infrastructure solutions, and more specifically a framework of these solutions, which have diverse functions and work together to counteract the negative impacts of pollution and poor air quality, are a viable solution to improvements of air quality and a sustainable approach to urban development.

Keywords: Air Quality Improvement; Community Engagement in Green Projects; Real-time Pollution Monitoring; Smart Sensors in Green Infrastructure; Sustainable Urban Development; Traffic-induced Air Pollution

ICSBE25_108

ASSESSING THE BENEFITS OF URBAN WETLANDS FOR SUSTAINABLE CITY PLANNING: CASE STUDY OF COLOMBO, SRI LANKA

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Abstract: Wetlands are being lost at an alarming rate due to urbanization, causing severe repercussions on the environment and local communities. Urban wetlands are crucial in maintaining ecological balance, providing essential ecosystem services, and enhancing urban life quality. In Colombo, Sri Lanka, rapid urbanization poses significant threats to these vital ecosystems, primarily due to the inadequate integration of wetlands into city planning. The main objective of this study is to examine the importance of incorporating urban wetlands into city planning in Colombo, Sri Lanka, focusing on their valuation and benefits for sustainable urban development. A mixed-method approach was adopted for this research. A researcher-administered questionnaire was used to gather information from 124 respondents familiar with the selected wetlands, which was analyzed using the double-bounded dichotomous choice contingent valuation method to assess the public's willingness to pay for conserving urban wetlands. Secondary data on the revenue and expenditure of the selected recreational urban wetlands were obtained from the authorities managing them to observe their financial sustainability. Key findings indicate that integrating wetlands into city planning can ensure a symbiotic relationship between urban development and ecological preservation. Environmental awareness, linked to purchasing power, significantly influenced individuals' willingness to pay. The study revealed that the average willingness to pay for urban wetland conservation was LKR 197. Introducing recreational activities was found to enhance the financial sustainability of these urban wetlands. Therefore, the state could play a major role in incorporating urban wetlands into city planning, making these areas valuable for education and recreation, and financing their maintenance through public interest and willingness to pay, which can promote community engagement in ensuring the sustainable integration of urban wetlands into city planning.

Keywords: Contingent Valuation; Sustainable Cities; Urban Wetlands; Urbanization; Willingness-to-pay

ICSBE25_130

A STUDY ON THE REMEDIATION OF A COASTAL LAGOON VIA A CONSTRUCTED FLOATING WETLAND AS A NATURE-BASED SOLUTION IN THE EASTERN SRI LANKA

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Abstract: This study evaluates the effectiveness of a pilot-scale Constructed Floating Wetlands (CFW) System implemented as a Nature-based Solution (NbS) in a coastal lagoon located in the Sainthamaruthu DS division of the Ampara district in the Eastern province of Sri Lanka. The experimental setup consisted of six Styrofoam containers, with and without *Canna indica* plants. Water from the Sainthamaruthu coastal lagoon was collected and replaced weekly in these containers. The water samples were analyzed weekly before the introduction of the CFW system (referred to as raw water) and after seven days of Hydraulic Retention Time (HRT) for Electrical Conductivity (EC), Total Dissolved Solids (TDS), Turbidity, Nitrate (NO_3^-), and Phosphate (PO_4^{3-}) to evaluate the CFW's removal efficiency. Additionally, Chemical Oxygen Demand (COD), Iron (Fe), Manganese (Mn), Volatile Phenol, and Anionic Surfactants were analyzed in the raw water to characterize the lagoon's water quality. The results indicated that among all the measured parameters in the raw water, EC (1030 ± 144.5 µS/cm), TDS (523.42 ± 65.3 mg/L), turbidity (19.35 ± 7.7 NTU), NO_3^- (4.1 ± 2.7 mg/l), and PO_4^{3-} (1.0 ± 0.3 mg/l) exceeded the standard levels for ambient purposes. Hence, the planted CFWs demonstrated higher overall mean removal efficiencies for EC (12.5%), TDS (13.4%), Turbidity (94%), NO_3^- (46.2%), and PO_4^{3-} (44.8%) than the unplanted CFWs. These findings suggest that the Sainthamaruthu coastal lagoon is polluted concerning EC, TDS, turbidity, NO_3^-, and PO_4^{3-}. The implementation of CFWs with *C. indica* emerges as an effective and sustainable nature-based treatment solution for lagoon remediation, indicating potential scalability for larger real-world applications.

Keywords: Aquatic Ecosystem; *Canna indica*; Coastal Lagoon; Removal Efficiency; Wastewater

ICSBE25_296

THE IMPACT OF BIOPHILIC DESIGN ON CHILD ENGAGEMENT IN PRESCHOOLS

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Abstract: By encouraging a connection with nature, biophilic design, a key idea in early childhood education, improves children's physical, mental, and emotional development. However, there isn't much empirical data from early childhood settings in Sri Lanka, especially from urban preschools. This study examines the relationship between natural features, human-nature relationships, and child involvement in a subset of Colombo preschools using the Biophilic Interior Design Matrix (BID-M) framework. The findings indicate that while emotional and cultural aspects of the human-nature relationship are underrepresented in preschool settings today, outdoor and plant elements are most strongly linked to increased involvement. This study highlights the necessity for locally modified, culturally sensitive biophilic design standards by offering the first empirical evidence relating biophilic design features to preschool engagement.

Keywords: Actual Natural Features; Biophilic Design Matrix; Biophilic Design; Child Engagement; Human Nature Relationship

ICSBE25_337

ASSESSING URBAN INFRASTRUCTURE DEVELOPMENT AND RESILIENCE IN DIGANA NEW TOWN: FROM VISION TO IMPLEMENTATION

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Abstract: Urban development in Sri Lanka has been a process that at times has weighed between the aspects of growth and long-term resilience. The new town of Digana, whose planning by the Danish architect Ulrik Plesner took place in the 1980s, was meant to be a climate-responsive and human-scale settlement for the displaced communities under the Mahaweli Development Programme. This study investigates how far Plesner's climate adaptation, neighbourhood coherence, and natural landscape integration principles have survived to support durable civil infrastructure forty years later. A qualitative case study methodology was adopted for the study, which was carried out through field observation, archival review, and photographic documentation. A thematic framework was used for the analysis of data, which considered the infrastructural, environmental, and social aspects of resilience. The assessment is grounded on the functionality of shop-house clusters, circulation networks, and public facilities during the ups and downs of changing weather and governance conditions. The findings reveal that Plesner's design had already laid down the grounds for and community-centered growth that eventually got muted under the burden of neglect, inept municipal governance, and environmental degradation. Nevertheless, the main spatial strategies, such as mixed-use clustering and terrain integration, still give people the power to find ways out of the situation. To sum it up, the research paper argues that the town of Digana reflects both the advantages and disadvantages of the planned settlements in Sri Lanka, claiming that resilient urbanism is a matter of constant governance, environmental consciousness, and continuous adaptation.

Keywords: Digana Town; Infrastructure; Resilience; Ulrik Plesner

ICSBE25_368

IDENTIFY THE RELATIONSHIP BETWEEN URBAN GREEN SPACE CHANGES ON LAND SURFACE TEMPERATURE USING MODIS DATA IN COLOMBO DISTRICT, SRI LANKA

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Abstract: Urbanization has major effects on local climates, particularly through the Urban Heat Island (UHI) phenomenon, where urban areas experience higher temperatures than their rural areas. This study examines the relationship between urban green space changes and Land Surface Temperature (LST) in the Colombo District of Sri Lanka from 2003 to 2023. We analyze trends in LST and the Normalized Difference Vegetation Index (NDVI) to understand how variations in green spaces affect urban land surface temperatures, using Moderate Resolution Imaging Spectroradiometer (MODIS) data. We used publicly available satellite images in the Google Earth Engine (GEE), which include the monthly global Aqua MODIS LST product ("MODIS/061/MYD21C3") with a 1 km spatial resolution, and the 16-day combined MODIS NDVI product ("MODIS/MCD43A4_006_NDVI") with a 250 m spatial resolution. The methodology of the study is as detailed in GEE, ArcGIS, and MS Excel, and was based on the analysis of five selected areas in the Colombo District, Colombo, Nugegoda, Homagama, Padukka, and Awissawella, respectively. Annual mean LST and NDVI were calculated to understand spatial and temporal patterns of LST and green space dynamics. Our findings revealed that there is an inverse relationship between green spaces and LST over the studied region, with an R-squared value of 0.2278 and a correlation coefficient (r) of -0.4772, which is a moderate negative correlation. This is consistent with the UHI effect, whereby increasing building area reduces vegetation cover, which leads to higher temperatures at the surface. Our analysis further shows that proper urban planning and management of green areas are important in mitigating the UHI effect, improving thermal comfort, and contributing to sustainable urban development, cities like Colombo in Sri Lanka.

Keywords: Green Space; Land Surface Temperature; MODIS LST; MODIS NDVI; Urban Heat Island Effect; Urbanization

ICSBE25_382

AGE-RELATED DIFFERENCES IN WAY-FINDING STRATEGIES AND COGNITIVE MAPPING IN BOTANIC GARDEN SETTINGS: A STUDY FROM ROYAL BOTANIC GARDENS, PERADENIYA

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Abstract: The present study explores age-related differences in spatial cognition, specifically examining way-finding strategies and cognitive mapping within the Royal Botanic Gardens, Sri Lanka, a natural, non-urban environment. Navigation and spatial orientation are essential cognitive processes affected by ageing; however, most existing research has concentrated on urban or virtual contexts. This study addresses a significant gap by analyzing how individuals' spatial cognition differs throughout the lifespan and how their way-finding strategies differ within a botanical garden setting. It highlights the utilization of navigation aids, as well as the interplay between exploratory behaviours and goal-directed navigation. Adopting a mixed-methods approach, data were collected through expert interviews, an online survey administered via Google Forms to 133 participants, systematic site observations with photographic documentation, and on-site visitor interviews conducted outside the garden with 70 participants. Results indicate substantial age-related differences in way-finding strategies. The analysis reveals that Most people, regardless of age or gender, rely on Google Maps, Apple Maps, or similar apps for navigation. Some combine apps with asking for directions, though this is less common, and traditional navigation methods are rarely used. Age and gender show little influence on navigation habits. The findings reveal that landmarks are the most prominent navigational aid, can be identified especially among adolescents (18-24 years) and young adults (25-34 years), whereas older groups depend more on signs (e.g., seniors 65+). Memory of routes is secondary, strongest in younger cohorts, whereas road bends/turns and other methods are minimally used. Overall, dependence changes from internal strategies in youth to external assistance in older persons, highlighting cognitive and experience differences between age groups. In the garden, maps were found to be less effective, and navigating and botanical signboards were less used. All types of collected data indicate the experience of confusion among people when navigating the vast garden setting.

Keywords: Age; Cognitive Mapping; Royal Botanic Gardens- Peradeniya; Way-finding Strategies

ICSBE25_435

INTEGRATING ECOLOGY AND URBAN PLANNING: A SYSTEMATIC REVIEW TOWARD URBAN SUSTAINABILITY

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Abstract: Urban populations will reach 68% of the world population by 2050, representing an unprecedented pressure on natural systems. This review aims to systematically analyse existing literature on the functionality of integrating ecological principles in urban planning that enhances urban sustainability outcomes. 20 peer-reviewed articles (2008–2023) were shortlisted on a PRISMA basis through the databases such as Google Scholar and ResearchGate. Keywords included 'urban sustainability,' 'ecological integration,' and 'climate adaptation.' Studies were excluded if they lacked clear ecosystem service applications or empirical relevance. Three themes are found in the review: biodiversity, habitat loss, and city planning. Kathmandu lost 16% of its natural habitats, Dhaka lost 42% of green cover, and 35% of agricultural land because of unplanned growth. Nature-based, low-impact city planning shows enhanced biodiversity and climate resilience. Proper planning reduces environmental degradation, as seen in comparing poorly planned cities like Dhaka and Kathmandu to properly planned ones. Since it is estimated that almost 90% of the next 2.5 billion urban dwellers will be in Asia and Africa, it is crucial to follow ecological principles. Currently, mainstream urban planning does not often include ecosystem services or indicators of resilience in its frameworks. Can try ecological planning matrices, GIS tools, and green infrastructure models. For urban development to be sustainable, it relies on having the same set of policies and cooperation among urban planners, experts in ecology, policymakers, and those living in the communities. The review emphasizes the importance of ecological integration in improving urban sustainability. The main conclusions show that resilience and biodiversity are positively impacted by nature-based solutions. Further work strives to achieve integrated evaluation guidelines, policy integration, and adaptive planning for different urban contexts.

Keywords: Climate Adaptation; Ecological Integration; Ecosystem Services; Green Infrastructure; Nature-based Solutions; Urban Sustainability

ICSBE25_515

FROM ROOF TO RESILIENCE: A REVIEW OF GREEN ROOF AGRICULTURE AS A NATURE-INSPIRED STRATEGY IN URBAN CLIMATE ADAPTATION

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Abstract: With the escalation of urbanization, cities face growing challenges of climate change, such as urban heat islands, flash flooding, food insecurity, and ecosystem degradation. This review is a critical analysis of Green Roof Agriculture (GRA) as a biomimicry-based innovation in nature that uses underutilized rooftops to create multifunctional, regenerative, and living spaces. The study critically reviews 127 peer-reviewed articles and grey literature on the typologies, performance measures, and scalability of GRA systems in a variety of climatic and socio-economic environments based on a systematic literature review in compliance with the PRISMA 2020 guidelines. The findings reveal that GRA offers substantial environmental benefits, including UHI mitigation (2 - 8 °C cooling), stormwater retention (50 - 90%), carbon sequestration, and improved air quality. Socioeconomic gains include enhanced urban food security, job creation, community engagement, and reduced infrastructure costs. The biomimetic design contents, especially the layered substrate regimes that simulate the stratification of soil horizons, the polyculture planting regimes, and the closed-loop hydric systems, are the key contents that were the focus of optimizing the performance. It has been shown that context-specific factors and results are present in empirical case studies in Singapore, Toronto, and Colombo, supported by GIS and ENVI-met simulation that indicate localized cooling impacts, energy-saving benefits, and food production potential. Despite the above-mentioned benefits, the review clarifies various problems that include structural limitations, high start-up costs, regulatory obstacles, and a lack of social awareness. In an attempt to mitigate these problems, a multi-phase, cross-sectoral implementation framework is outlined that incorporates environmental, technological, policy, and socio-economic tiers. This review eventually provides the mainstreaming of GRA in urban climate adaptation with a conceptual and a practical scheme. This is an argument for why interdisciplinary research, positive policy frameworks, and inclusive stakeholder involvement are necessary. Finally, GRA repositions rooftops as important infrastructures in resilient city planning in which ecological intelligence, food production, and climate resilience meet. GRA is an integrative, systemic reaction to the convergent dangers that are likely to face cities in the near future that is capable of adapting to these threats with natural solutions.

Keywords: Biomimicry; ENVI-met Modelling; Green Roof Agriculture; Nature-inspired Solution; Urban Food Security

ICSBE25_546

A REVIEW OF PLANT SPECIES SUITABILITY FOR GREEN WALLS IN URBAN AGRICULTURE

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Abstract: Adapting environment friendly solutions into sustainable urban design has become increasingly important due to rapid urbanization and climate-driven ecological problem. Green infrastructure such as green facades, green roofs, and green walls, are now widely implemented as key components in the sustainable urban designs. As part of these solutions, green walls mitigate the urban heat island effect, reduce greenhouse gas emissions and improve the aesthetic value of built environments. This review examines the selection of suitable plant species for green walls in urban settings while achieving sustainability. In this context, the selection of appropriate plant species for green walls is essential to their effectiveness, low maintenance and long-term sustainability. Plants selection process should consider their adaptability to local environmental conditions, resistance to abiotic stresses, maintenance requirements, and the ecological contributions to the urban ecosystem. Native plant species in a green wall is beneficial due to their adaptation to local conditions. Species that have a high capacity to absorb atmospheric pollutants contribute to improve air quality and reduce the urban heat island effect. Plant species with seasonal flowering, decorative foliage, or colour variation can significantly enhance the aesthetic value of the built environments. plants capable of growing in artificial substrates such as herbaceous perennials, ferns, and grasses, are commonly used in green walls. The Density of the foliage and leaf area index play a main role in the thermal regulation of green walls. Overall findings suggest that the selection of suitable plant species is directly affects to optimal performance of the green wall.

Keywords: Green Infrastructure; Green Walls; Species Selection; Sustainability; Urban Agriculture

ICSBE25_549

LONG-TERM EFFECTIVENESS OF GREEN BUILDING STRATEGIES - QUANTIFYING BIODIVERSITY CHANGES IN AN INDUSTRIAL ECOSYSTEM: CASE STUDY OF HIRDARAMANI MIHILA AGALAWATHTA FACILITY

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Abstract: The apparel industry encounters raising challenge to integrate environmental sustainability aspects into its operations, transforming beyond the traditional aspects of pollution mitigation to modern proactive ecosystem enhancement. This study discusses a comparative analysis of the species diversity at the Hirdaramani Mihila (Agalawatta) apparel facility in Sri Lanka, a pioneer in eco-friendly apparel manufacturing. By comparing with the 2008 baseline biodiversity assessment and surveillance assessment in 2024, this paper discusses the changes in species diversity and composition over a 16-year period. Baseline assessment recorded 73 species of fauna and 146 species of flora, while the surveillance assessment discovered a significantly improvement in species diversity, with a total of 191 fauna species and 152 flora species. Species diversity percentage increases were observed across multiple taxa, including dragonflies and damselflies (19 species), butterflies (36 species), and birds (73 species). these findings imply that the relationship between green building strategies implementation impacted to the facility's success as a biodiversity significance on-site green spaces, forest patches, and a marshland habitat, etc. This study served as a valuable case study, highlighting a replicable framework for manufacturing facilities transformation from environmental polluters to conservators and active participants in local ecosystem management.

Keywords: Biodiversity; Ecosystem Enhancement; Green Building; Industrial Sustainability; Sri Lanka

ICSBE25_567

WASTE TYRES AS A GREEN SOLUTION FOR RAILWAY BALLAST

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Abstract: Railway transportation is one of the vital modes of travel in Sri Lanka and all around the world since industrial revolution. Ballast, the particle primarily of crushed stone aggregates, is much essential for track stability and load distribution to the subgrade. However, it starts to degrade due to the continuous repeated train loading and environmental factors. This study investigates the addition of shredded rubber from the used recycled tires as a part replacement for traditional ballast used, aiming to increase both performance and sustainability. Advantages such as improved energy absorption, reduced particle breakage, noise reduction, and environmental benefits are obtained due to the partial replacement. But the addition of rubber should be in an optimum amount, and the research was to determine the optimal rubber content (by weight) that improves mechanical behavior without compromising strength. As the experimental works, Large-scale direct shear tests were conducted under three normal stresses (30, 60, and 90 kPa) on fresh ballast and rubber intermixed ballast systems with the addition of two size ranges (8–16 mm and 19–26.5 mm) at 10% and 15% selected as the replacement levels for the analysis. Results obtained showed that the addition of rubber reduced particle breakage by up to 45% (Ballast Breakage Index), while peak shear stress decreased by 29–38%. On the other hand, the friction angle also decreased, with the maximum reduction of 23% observed for 10% addition using 19–26.5 mm rubber. Furthermore, rubber partial replacement reduced dilation, thereby improving stability by limiting the excessive particle movement and maintaining a more compact structure under continuous loading. Overall, the findings highlight the potential of shredded rubber in railway ballast to enhance durability, reduce maintenance requirements, and promote sustainable tire recycling in Sri Lanka.

Keywords: Crumb Rubber; Degradation; Friction Angle; Railway Ballast; Shear Strain; Shear Strength

CIRCULAR ECONOMY ACROSS THE BUILT ENVIRONMENT

ICSBE25_065

DESIGNING A SCALE-UP FRAMEWORK WITH LIFE-CYCLE THINKING: ENHANCING THE SUSTAINABILITY OF HCL ACID LEACHING FOR GRAPHITE ANODES IN LITHIUM-ION BATTERY

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Abstract: Lithium-Ion Batteries (LIBs) play an important role in reducing carbon emissions in energy systems, but the environmental impacts of their production are not fully understood. Graphite, widely used as an anode material, requires an HCl acid leaching purification method to meet the performance standards of LIBs. This study presents a conceptual framework to guide the scale-up of HCl acid-leaching purification of Sri Lankan vein graphite, integrating principles of life cycle thinking and preliminary environmental assessment into early-stage process development. The framework aims to bridge laboratory-scale processes and industrial-level planning by supporting preliminary energy and environmental assessment during early process development. Here, the methodology includes five steps: establishing laboratory protocols, designing the process flowchart, scaling independently each process step, linking the steps into a complete system and assessing energy demands. This process involves liquid-phase batch reactions followed by purification and drying stages. The framework models key energy-consuming operations, including reaction heating, stirring and drying, using thermodynamic and geometric scaling laws. This study shows that reaction heating increases linearly from 3.76 to 376 kWh. On the other hand, the heat loss amount rises from 0.04 to 0.77 kWh, with its proportional contribution drops to 19.25% at the largest scale due to improved thermal efficiency. As production scales up, total reaction energy consumption increases from 5.28 to 476.92 kWh. This corresponds to approximately 90% of the theoretical linear scaling. Stirring energy is not behaving linearly and increasing from 0.007 to 0.151 kWh. However, all volumes show that the drying energy remained constant at 13.5 kW. Although limited to laboratory-level data, a foundation path for graphite purification scaling-up processes is provided with this framework. Further, this approach can be applied to related steps and make the completed cradle-to-gate assessments. Overall, this study contributes a structured framework to inform decision-making and supports sustainable industrial transitions in battery material production.

Keywords: Graphite Anode; HCl Acid-leaching Process; Life Cycle Thinking; Lithium-ion Battery; Scale-up Framework

ICSBE25_071

FABRICATION OF CERAMIC ENGOBE FOR TILE MANUFACTURING IN SRI LANKA

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Abstract: There are three main types of tile production in Sri Lanka, divided according to their water absorption ability: Porcelain (water absorption percentage below 0.5%), Vitrified (water absorption percentage between 0.5% to 3.0%), and Ceramic (water absorption percentage between 3% to 6%). The water absorption capacity of the tiles is controlled by changing the temperature at which the tiles are fired. Glazes are applied to these green tiles, and the first glaze layer to be used is the engobe glaze layer. An engobe layer is a high-clay slurry that balances the thermal shock and colour differences between the body tile and base layer of tile production. The major raw materials for the engobe layer are currently imported, incurring a high cost. The current study aimed to develop a glaze using exclusively Sri Lankan raw materials. Raw materials used for engobe composite preparation include four major components: glass (quartz and recycled soda lime glass powder), fluxing materials (potassium feldspar), white colorant (zirconium silicate), and refractory agent (calcination kaolin). The mineralogical composition of the engobe composite was characterized using X-ray Diffraction (XRD) analysis. The engobe fabricated using locally available raw materials exhibited a water absorption of 2.40%, a Lightness value (L-value) of 83.7°, a Coefficient of Thermal Expansion (CTE) of 7.90 ppm/°C, and an optimal firing temperature of 1154 °C, which corresponds with the characteristics of commercial engobe. The Life Cycle Cost Analysis (LCCA) estimated the cost of 1 kg of engobe, made from locally available raw materials, to be LKR 85.60, which is 50% lower than that of a commercially available engobe composite. Our study suggests that the engobe composite prepared in this study shows potential as a replacement for commercially imported engobe, thereby reducing tile manufacturing costs and providing value-added benefits to the minerals available in Sri Lanka.

Keywords: Coefficient of Thermal Expansion (CTE); Engobe; Glaze; Tile Manufacturing; Water Absorption

ICSBE25_262

DESIGN OF LIGHTWEIGHT GREEN ROOF BEDS TO IMPROVE WATER RETENTION AND THERMAL RESISTANCE USING ORGANIC WASTE

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Abstract: Green roofs help mitigate urban heat island effects, air pollution, and flash flooding, while enhancing biodiversity, aesthetics, and urban agriculture. Through the sustainable utilisation of organic waste materials, this study aims to improve heat resistance and water retention while lowering the weight of green roof beds. Six types of organic wastes, namely Rice Husk (RH), Corn Cobs (CC), Banana Stems (BS), Scraped Coconut (CS), Tea Leaves (TL) and King Coconut Husk (KH), were processed into clay-coated cubes and carbonised in a muffle furnace at 900 °C for 20 minutes. These cubes are intended to replace the green roof bed's drainage layer, which is typically filled with gravel or construction debris. The cubes were tested to evaluate drying characteristics, water absorption, water desorption, water retention, heat resistance and bulk density. The highest water absorption percentage was 47.7% for BS cubes, followed by CS, KH, RH, CC, clay only (CO), and TL cubes. The results showed that the use of organic waste reduces the cube weight by 26% on average. Heat resistances of the cubes were compared by calculating time constant (τ) values using the lumped capacitance equation with measured temperature gradients inside an oven. RH, CS, TL, and BS cubes exhibited resistance increases of 49.81%, 25.75%, 25.03%, and 13.17% respectively. The designed green roof beds using clay cubes showed good plant growth, water permeability and drainage. The results indicate that combining organic waste with clay can offer improved water retention and heat resistance while reducing rooftop weight. This study presents an innovative, eco-friendly, cost-effective, and scalable green roof system that promotes sustainable urban development and circular economic concepts through waste upcycling. Additionally, the outcomes of this research help to further improve the cube properties through design changes, such as further reducing the clay-to-waste ratio and increasing cube size.

Keywords: Green Roofs; Heat Resistance; Organic Waste; Water Absorption; Weight Reduction

ICSBE25_264

DESIGN OF LIGHTWEIGHT GREEN ROOF BEDS TO IMPROVE WATER RETENTION AND THERMAL RESISTANCE USING PAPER WASTE

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Abstract: Rapid urbanization and climate change lead to an increase in the urban heat island effect, poor stormwater control, and rising waste generation. Green roofs offer a viable mitigation strategy, yet conventional systems are limited by heavy, less heat-resistant, and less water-absorbing drainage material. This study introduces a lightweight, sustainable green roof substrate made from clay-covered, carbonised (at 900 °C for 20 mins) paper waste cubes produced from tissue paper (T), cement bags (CB), paper cups (PC), canteen wastepaper (CWP), and vehicle air filters (VAF). The cubes were tested to evaluate drying characteristics, water absorption, water desorption, water retention, heat resistance, and bulk density. The results revealed that when wastepaper is used, cubes achieved notable weight reduction, ranging from 32.5 % to 21.4%. VAF cubes exhibited the greatest drop in bulk density (from 1.89 g/cm^3 to 1.25 g/cm^3), reducing structural load. CB cubes had the highest drying rate of 0.02 g/min. VAF cubes recorded the highest water absorption (50.53%), water retention (17.01%), and longest retention duration (18 days), outperforming the clay-only cubes (13 days). Drainage tests showed lower permeability in VAF (5.28×10^{-6} m/s), indicating prolonged moisture availability. Heat resistances of the cubes were compared by calculating the time constant (τ) values using the inside and outside surface temperature values of the cubes during a heat conduction test. Except for the PC cubes, all the other wastepaper cubes showed increased heat resistance compared to clay-only cubes, ranging from 60.7% (T) to 12.6% (VAF). *Portulaca grandiflora* showed the best growth on VAF cubes, reaching 8.68 cm height and 18 leaves, confirming excellent plant support performance. This research explores using recycled paper waste in green infrastructure to reduce landfill waste, conserve resources, and promote a circular economy. Aligned with SDGs 11 and 12, this scalable system presents a low-cost, high-performance solution for sustainable urban development in tropical regions.

Keywords: Circular Economy; Green Roofs; Paper Waste Upcycling; Sustainable Construction; Thermal Resistance; Water Retention

ICSBE25_504

VALORIZATION OF COPPER-ENRICHED GRIT WASTE FROM SHIP SURFACE BLASTING FOR SUSTAINABLE BRICK PRODUCTION

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Abstract: This study investigates the reuse of an industrial by-product, copper-loaded grit waste (a material produced during grit blasting of ship hulls), in the manufacture of fired clay bricks. Traditional brick production consumes large amounts of natural resources and produces significant carbon dioxide emissions. Grit waste contaminated with ship paint residues during blasting can harm the environment if it is dumped without proper treatment, due to its heavy metal content. The study proposes a circular economy model where industrial waste is incorporated into brick making, reducing environmental impact and conserving raw materials. Four different brick mixtures (M1, M4) were prepared using various proportions of clay, grit waste, fly ash, and biochar. Bricks were shaped using common wooden moulds, air-dried for 14 days, then fired in a muffle furnace at 900 °C for 8 hours. Tests conducted included compressive strength (ASTM C67), water absorption (ASTM C373), and leachability assessment through a modified water leaching test followed by Atomic Absorption Spectroscopy (AAS). The optimal mix, M2 (65% clay, 25% grit waste, 5% fly ash, 5% biochar), exhibited a compressive strength of 2.93 MPa and water absorption of 17.02%, suitable for non-load-bearing applications. Leachability results revealed heavy metal levels (Cu: 0.02 ppm, Fe: 0.10 ppm) well below regulatory limits, indicating no environmental risk. The findings demonstrate that copper-enriched grit waste, when properly treated and incorporated, can be used as a construction material. This valorisation aligns with sustainable development goals and offers a waste management solution for the ship repair industry, supporting the principles of green construction.

Keywords: Biochar; Circular Economy; Compressive Strength; Fly Ash; Industrial Waste Valorisation; Leachability; Water Absorption

ICSBE25_548

RECYCLED CRUSHED CONCRETE MATERIAL FROM CONSTRUCTION WASTE AS A SUSTAINABLE, COST-EFFECTIVE ROADBASE SOLUTION

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Abstract: Logan City Council, Queensland, Australia, has pioneered a sustainable and cost-effective solution for road base construction by repurposing concrete waste. In response to escalating urban development and the diminishing availability of quality natural aggregates, the Council has addressed both environmental and logistical challenges posed by the daily influx of concrete waste at its Kingston fill site. Traditional burial methods have proven unsustainable and economically unviable, prompting a strategic shift toward circular economy principles. This initiative aligns with Australia's national commitment to achieving net-zero carbon emissions by 2050 and supports the United Nations Sustainable Development Goals. By diverting concrete waste from landfill and reprocessing it into road base material for low-traffic volume roads, the Council has demonstrated a practical pathway to reduce greenhouse gas emissions, conserve natural resources, and extend the operational life of waste disposal infrastructure. The presentation outlines the methodology, trial processes, and performance outcomes of the recycled concrete road base, highlighting its technical viability and economic benefits. It also underscores the broader significance of adopting low-carbon construction practices in municipal infrastructure planning. The insights gained offer a replicable framework for other local governments, including those in Sri Lanka and similar jurisdictions, seeking to implement environmentally responsible and financially prudent road construction strategies. Through this work, Logan City Council exemplifies how local authorities can lead in the delivery of sustainable infrastructure, fostering community resilience while making meaningful contributions to global climate targets.

Keywords: Low-traffic Roads; Recycled Aggregate; Sustainable Construction; Sustainable Development Goals

CARBON FOOTPRINT; NET-ZERO PATHWAYS AND LOW-CARBON DEVELOPMENT

ICSBE25_080

ENERGY EFFICIENCY OPTIMIZATION IN TYRE MANUFACTURING: INTEGRATED VFD-BASED COMPRESSOR CONTROL, SOLAR LIGHTING, AND BATCH-OFF FAN AUTOMATION IN A MEDIUM-SCALE INDUSTRIAL SETTING

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Abstract: This study details a thorough energy efficiency improvement project carried out at a medium-sized tyre manufacturing plant in Sri Lanka. The study focuses on three significant electricity-intensive systems: the batch-off cooling fan conveyor, the outdoor lighting network, and a 75-kW air compressor. Installing a Variable Frequency Drive (VFD) for the air compressor allowed for dynamic load control, which reduced daily energy consumption by 27%, decreased peak demand by 45%, and improved power factor from 0.82 to 0.99. It was suggested to retrofit outdoor lighting with solar-powered LED fixtures with motion sensors, which would completely eliminate the need for grid electricity and result in monthly savings of about LKR 42,500. VFDs and laser detection were used to automate the batch-off fan conveyor system, and thermal energy transfer modelling confirmed a 50% reduction in energy consumption, or 22,500 kWh per year. Collectively, these interventions are expected to save more than 133,000 kWh of energy annually and cut CO_2 emissions by more than 54 metric tonnes. This paper provides practical insights into cost-effective, scalable energy-saving technologies for industrial applications in emerging economies.

Keywords: Batch-off Fan Automation; CO_2 Reduction; Energy Efficiency; Solar Lighting; Tyre Manufacturing; Variable Frequency Drive

ICSBE25_212

MODE CHOICE AND MODE SHIFT DECISIONS FOR ALTERNATIVE BUS ROUTE SYSTEMS

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Abstract: Urban congestion and inefficient public transport are growing concerns in the Kandy district, where commuters frequently face delays, discomfort, and unreliable services. This study aimed to understand how commuters choose their mode of transport and explore the potential for shifting from private to public options and public to public (alternative route), particularly through *direct, non-transit bus route systems.* Survey data and field observations were collected across the district, and a Multinomial Logit (MNL) modelling approach was used to analyze mode choice behaviour based on key factors such as travel time and travel cost. Model estimations revealed that private transport modes - motorbikes, cars, and three-wheelers are preferred respectively, due to their convenience and time efficiency. In contrast, buses were less favoured where travel time was high. To assess the possibility of mode shift, Stated Preference (SP) analysis and elasticity analysis were conducted. Findings showed that many commuters, including existing public and private users, are willing to shift to direct, non-transit bus routes, subjected to offering improved speed, comfort, and affordability. However, concerns such as overcrowding, longer durations, lack of comfort, and safety issues were key reasons for reluctance among travellers. The study highlights the importance of addressing these barriers by improving bus services through better scheduling, route planning, and enhanced passenger experience. It recommends that transport planners and policymakers prioritize user-centered investments in direct public transport services to encourage mode shift, reduce road congestion, and improve travel satisfaction. Overall, the research supports the development of a more sustainable, efficient, and commuter-friendly transport system for the Kandy district by identifying key factors that influence travel behaviour and providing actionable recommendations.

Keywords: MNL Modelling; Mode Choice; Mode Shift; Public Transport; Travel Behaviour

ICSBE25_294

HYDROGEN POWERTRAIN MIX IN FREIGHT VEHICLES: A TECHNICAL REVIEW OF ARCHITECTURES, PERFORMANCE, AND R&D TRENDS

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Abstract: The decarbonization of freight transport presents a pressing challenge in the global effort to mitigate climate change, particularly within the long-haul and Heavy-Duty Vehicle (HDV) sector, where battery-electric technologies remain constrained by energy density and range limitations. Hydrogen-based powertrains—encompassing Fuel Cell Electric Vehicles (FCEVs), Hydrogen Internal Combustion Engines (H_2-ICEs), and hybrid architectures—have emerged as viable alternatives due to their high energy density, rapid refuelling capabilities, and compatibility with substantial payload requirements. This review provides a systematic and technical evaluation of hydrogen powertrain systems for freight applications. Core components, including fuel cell stacks, hydrogen storage technologies (gaseous, cryogenic, and solid-state), and drivetrain integration strategies, are analyzed in detail. Operational performance metrics such as energy efficiency, torque delivery, vehicle range, and refuelling duration are examined under real-world duty cycles. Case studies of pioneering pilot programs—such as the Hyundai XCIENT, Toyota-Kenworth T680, and MAN hTGX—highlight the progress and limitations of current deployments. Additionally, the review assesses comparative Technology Readiness Levels (TRLs), Total Cost of Ownership (TCO), and infrastructure readiness. Finally, critical research priorities are identified in materials engineering, system optimization, and policy coordination to support the scalable transition to hydrogen-powered freight transport.

Keywords: Energy Efficiency and System Integration; Freight Transportation Decarbonization; Fuel Cell Electric Vehicles (FCEVs); Hydrogen Internal Combustion Engines (H_2-ICEs); Hydrogen Powertrains

ICSBE25_297

WILLINGNESS TO ADOPT CARBON NEUTRALITY IN TOURISM: AN EMPIRICAL STUDY OF TOURISTS AND HOTELIERS IN NUWARAELIYA, SRI LANKA.

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Abstract: This article examines the readiness of tourists and Hoteliers in Nuwara Eliya, Sri Lanka, to adopt carbon-neutral practices and apply a carbon-neutral itinerary map. It addresses the increasing concern regarding tourism and the environmental impact and the domineering for sustainable development within the industry. To attain these contexts, mixed methods research approach was abided. Qualitative data was gathered from key stakeholders inside the hotel field through the in-depth interviews and focus groups directing to understand their sensitivities, challenges, and motivations. Instantaneously, quantifiable data was collected from the tourists via surveys, measuring their willingness to engage in carbon-neutral tourism, with their current consciousness of environmental matters, and their preferences for sustainable travel options. The results show that both tourists and hotel owners are generally open to using carbon-neutral methods. The study highlights the critical standing of implementing structured programs, such as the proposed carbon-neutral itinerary map, in fostering environmental consciousness and encouraging the adoption of eco-friendly travel activities. These initiatives can be served as some of the powerful tools for educating both the tourists and the industry professionals, guiding towards for more sustainable choices, and eventually contributing to the long-term environmental wellbeing of the tourist destinations like Nuwara Eliya. This research offers some valuable insights for policymakers, operators of tourism, and for conservation organizations looking to promote responsible tourism and minimalize its ecological footprint.

Keywords: Carbon Footprint; Carbon Neutrality; Empirical Study; Itinerary Map; Sustainable Tourism

ICSBE25_318

ESTIMATING THE CARBON FOOTPRINT OF PERSONAL ELECTRICAL EQUIPMENT USAGE AMONG UNIVERSITY STUDENTS: A CASE STUDY FROM THE UNIVERSITY OF KELANIYA, SRI LANKA

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Abstract: Assessing individual-level carbon footprints in university contexts is an increasingly recognized aspect of sustainability research. Using the University of Kelaniya as a case study, this study aims to assess the daily and annual carbon footprint stemming from the usage of electrical equipment by university students. To gather information on the daily usage of selected electrical equipment, a convenience sampling technique was used to select 100 students who participated in the online survey. Sri Lanka's national electricity emission factor of 0.7123 kg CO_2e/kWh and thermal energy fraction of 49% were applied to calculate the energy consumption to yield the kg CO_2e emissions. Results indicated that the average daily electricity consumption per student was 1.52 kWh, which corresponds to 0.53 kg CO_2e per day. This equates to approximately 193.45 kg CO_2e per student annually. Among the equipment, ceiling fans contributed the highest share of emissions, while the phone chargers contributed the least. Assuming these findings are extrapolated to the entire student population of the university, the annual carbon footprint from personal electrical equipment usage was found to be significantly high. The results of this study emphasize the fact that even basic, small-scale electrical usage by individuals can add up to a sizeable footprint, contributing meaningfully to the overall emissions.

Keywords: Carbon Footprint; Emissions; Energy Consumption; Sustainability; University Students

ICSBE25_335

COMPREHENSIVE CO_2 EMISSION ASSESSMENT OF PAVEMENT DESIGN ALTERNATIVES USING SAT4P TOOL

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Abstract: Climate change and global warming represent critical environmental challenges, largely caused by increasing concentrations of Greenhouse Gases (GHG) in the atmosphere. Among these gases, carbon dioxide (CO_2) constitutes the most significant share. Globally, the transportation sector is a leading source of these emissions, while activities associated with pavement construction and maintenance account for a considerable share of the construction industry's overall emissions. Promoting sustainable development is essential to lessen these impacts, and an important step in this process involves precisely measuring emissions across the various phases of a pavement's life cycle to achieve long-term climate objectives. A variety of carbon emission calculators and Life Cycle Assessment (LCA) tools have been developed worldwide and nationally to meet different project and policy needs. In Australia, and specifically in Queensland, the Department of Transport and Main Roads (TMR) uses the Sustainability Assessment Tool for Pavements (SAT4P) to evaluate emissions associated with pavement projects. This study reviews existing carbon emission tools and compares SAT4P with the National Highways Carbon Tool, the Project Emissions Estimation Tool (PEET), the Life Cycle Assessment of Pavements (LCAP), and LCA PAVE. The analysis focuses on assessing SAT4P's capabilities and accuracy. To support the comparison, several pavement designs were modelled in Circly to ensure adequate structural performance, and their emissions were estimated using SAT4P to identify a low-carbon design approach. Findings show that granular pavements generally have lower emissions than asphalt-surfaced alternatives, largely due to the energy-intensive nature of asphalt production, with emissions varying according to asphalt type and layer thickness. Fewer maintenance and rehabilitation activities result in lower overall emissions. The incorporation of recycled materials in pavement layers can further reduce emissions depending on the proportion and depth of replacement. Finally, emission factors have been established for common pavement types in Australia to support future project assessments.

Keywords: Carbon Tool; CO_2 Emission; Pavement; SAT4P; Sustainability

ICSBE25_418

IS THE EMISSION TRAJECTORY OF SRI LANKA IN LINE WITH GLOBAL STRATEGIES TO FACE CLIMATE CHANGE? AN EXTENDED KAYA IDENTITY ANALYSIS

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Abstract: This study investigates the driving factors behind carbon dioxide (CO_2) emissions in Sri Lanka from 2000 to 2023 using the Kaya Identity framework and Logarithmic Mean Divisia Index (LMDI) decomposition method. By decomposing emissions into key contributing components, such as population growth, GDP per capita, energy intensity, and carbon intensity, the analysis explores how socio-economic and energy-related variables influence emission trends. The study further extends the Kaya framework by incorporating the role of renewable energy, providing a more holistic view of the decarbonization process. The findings reveal that economic growth and population increase have exerted upward pressure on emissions, while improvements in energy intensity and the modest integration of renewables have contributed to emission reduction. However, carbon intensity remains a significant challenge, highlighting the continued reliance on fossil fuels within Sri Lanka's energy mix. Moreover, analysis indicates that although the share of renewable energy has increased gradually over time, its impact has not been strong or consistent enough to fully offset the emissions arising from economic and population growth. The paper further provides a set of policy recommendations aimed at promoting a low-carbon transition. These include enhancing investment in renewable energy technologies, strengthening institutional coordination, developing carbon pricing mechanisms, and ensuring energy equity during the transition. Regional dynamics are also acknowledged, emphasizing the importance of South Asian cooperation in addressing cross-border environmental impacts and enabling technology sharing. The study acknowledges limitations such as data constraints and the exclusion of sector-specific dynamics, suggesting that future research should adopt a broader regional lens with comparative insights across Asian economies. Overall, the paper contributes to the growing body of empirical work that links macroeconomic trends with environmental outcomes and offers practical pathways for sustainable energy and climate policy in emerging economies like Sri Lanka.

Keywords: Carbon Intensity; CO_2 Emission; Kaya Identity; Renewable Energy

GEOTECHNICAL ENGINEERING; INNOVATIONS IN GEOTECHNICS AND RESILIENT GROUND ENGINEERING

ICSBE25_032

AN ASSESSMENT ON SUSTAINABILITY AND SHORT AND LONG TERM COMPRESSIBILITY CHARACTERISTICS OF EXPANSIVE SOILS STABILIZED WITH LIME, CEMENT AND FLY ASH

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Abstract: Expansive soils are highly problematic soils that undergo large volume changes due to fluctuations in the moisture content, and it leads to the development of cracks and affects the stability of foundations and structures. This study investigated the compressibility of expansive soils stabilized with lime, cement and fly ash. In this study, an expansive soil collected from the Central Province of Sri Lanka is characterized and its compressibility characteristics of stabilized soils are investigated. Further, this study evaluated the impact of stabilization in the consolidation settlement of shallow foundations. Also, the most effective stabilizer in terms of compressibility, cost and emissions was determined using Multi-Attribute Utility Theory (MAUT). This study utilized an experimental approach to determine characteristics of expansive soils and compressibility parameters of raw and stabilized samples. Particle size distribution, Atterberg limits, free swell, Proctor compaction, and direct shear tests were conducted on raw and 1D consolidation tests were performed on stabilized expansive soil after 14 and 128 days of air curing, representing short and long durations of curing. The influence of short and long durations of curing of expansive soils stabilized with cement, lime and flyash, on the consolidation settlement of shallow foundations was analysed based on the coefficient of volume compressibility values using analytical methods. The optimum proportions of stabilizers based on Unconfined Compressive Strength (UCS), swell pressure, %swell, cost and emissions were identified as 4% for cement, 3% for lime, and 15% for fly ash by dry weight of soil. A 128-day curing period significantly reduced the compressibility of stabilized soils and exhibited a notable reduction in swell pressure as compared to those of expansive soil cured for 14 days. The pre-consolidation pressure significantly increased in stabilized soil, particularly with cement, indicating that the soil can withstand higher pressures without undergoing plastic deformation. Cement-treated soils exhibited greater reduction in compression index (C_c) and coefficient of volume compressibility (m_v). As a result, cement becomes the optimum stabilizer based on the consolidation settlement. However, analysis based on MAUT shows that fly ash is the most preferred stabilizer in terms of compressibility, cost and emissions.

Keywords: Compressibility; Consolidation; Expansive Soil; Foundation; Stabilization

ICSBE25_053

BEARING CAPACITY OF SHALLOW FOUNDATIONS ON SEA SAND

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Abstract: Sandy soils create significant challenges for building foundations and structures due to their adverse geotechnical properties. Sandy ground increases the risk of foundation instability, particularly in coastal or earthquake-prone areas where liquefaction may occur. However, sand is an effective material for improving the stiffness of soft soils and consequently enhancing bearing capacity. River sand is generally popular for such applications; however, excessive mining of river sand has adverse environmental impacts. Conversely, sea sand and manufactured sand (M-sand) are gradually becoming popular as sustainable alternatives to river sand in the construction industry. Nevertheless, limited engineering information is available on the geotechnical properties and load-bearing capacity of sea sand and M-sand, as they are relatively unconventional materials. Therefore, this study was focused on investigating the load-bearing capacity of shallow foundations on sea sand and manufactured sand by using a laboratory-scaled physical model. A series of tests was conducted by applying a monotonic load on two shapes of square shape steel plates (width 100 mm and 150 mm, with 3 mm thickness) those used as shallow foundations. Foundation settlements were monitored under monotonic loading at different soil densities, and the bearing capacity of sea sand was further examined under varying lateral confinement conditions, considering confinement as a ground improvement technique. Numerical analysis was conducted to develop a model for further study of the behaviour of sea sand under different load conditions and it was validated by the experimental data. The results revealed that M-sand exhibited a higher bearing capacity than sea sand, while the bearing capacity of sea sand increased significantly up to about five times when the lateral confinement distance was reduced.

Keywords: Confinement Effect; Manufactured Sand; Sea Sand; Shallow Foundation

ICSBE25_059

LIFE CYCLE IMPACT ASSESSMENT OF EXPANSIVE ROAD SUBGRADE STABILIZED WITH GEOPOLYMERS AND ORDINARY PORTLAND CEMENT

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Abstract: Expansive soils pose significant construction challenges due to moisture-induced swelling and shrinking. In road construction, an expansive subgrade can lead to the formation of longitudinal cracks and durability issues. Traditionally, Ordinary Portland Cement (OPC) is used for chemical stabilization due to its availability and effectiveness in enhancing soil properties; however, its use contributes to Global Warming (GW). Geopolymers (GP), which are aluminosilicate precursors activated by alkaline activators, have emerged as sustainable alternatives. GP are classified into two-part (TP-GP) and one-part (OP-GP). TP-GP uses liquid activators, while OP-GP uses solid activators and water with solid precursors. To date, there are no studies focusing on comparative Life Cycle Impact Assessment (LCIA) for fly ash-based OP-GP, TP-GP, and OPC-based road subgrade stabilization. Therefore, this study assesses the environmental impacts of OP-GP, TP-GP, and OPC in stabilizing expansive subgrade through LCIA. The research methodology involved the goal and scope definition of the study, the data collection, which is referred to as Life Cycle Inventory (LCI), performing LCIA, and the interpretation of the study. The LCIA was conducted by using the ReCiPe midpoint method in SimaPro software, based on the cradle-to-construction approach. Ultimately, the optimum treatment method was selected by considering the total environmental impact of eighteen categories. The LCIA results indicated that OPC has the lowest overall environmental impact across all eighteen categories, followed by OP-GP and then TP-GP. However, OPC shows the highest GW impact, primarily due to emissions from the clinker production process. Between the two geopolymer treatments, TP-GP exhibits a higher overall environmental impact, largely because of the significant impact associated with Na_2SiO_3. In contrast, OP-GP has a higher GW impact, attributed to the greater quantity of NaOH used, which carries a high CO_2 emission factor.

Keywords: Expansive Road Subgrade; Geopolymers; Life Cycle Impact Assessment; Ordinary Portland Cement

ICSBE25_109

AN ASSESSMENT ON SUSTAINABILITY AND SHORT AND LONG TERM SHEAR STRENGTH CHARACTERISTICS OF EXPANSIVE SOILS STABILIZED WITH LIME, CEMENT AND FLYASH

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Abstract: Expansive soil is highly problematic in construction due to its swelling behaviour. Chemical stabilization is one of the successful methods used in the construction industry to improve its properties. Evaluating the effect of stabilization on shear strength parameters and the effect of curing period is important for assessing the stability of the soil. This study investigates the short and long-term shear strength characteristics of an expansive soil stabilized with optimum percentages of lime, fly ash, and cement determined based on Uniaxial Compressive Strength (UCS). For the investigation of short and long-term behaviour, soil samples were cured for 14 and 128 days. Initially, a series of laboratory tests was conducted to determine shear strength parameters of an expansive soil of medium expansivity optimally stabilized with lime, cement and flyash cured for 14 days and 128 days. This was followed by stability analyses using GeoStudio Slope/w software to obtain the factor of safety of uniform slopes consisting of above short and long-term stabilized expansive soils by varying the slope angle from 15^0 to 60^0 and height varying from 4 m to 10 m. An analysis using Multi-Attribute Utility Theory (MAUT) was performed to identify the most effective stabilizer, considering not only the enhancement of shear strength but also considering cost effectiveness and environmental factors such as carbon dioxide emissions. From the above study, it can be concluded that cement, lime and fly ash are effective as stabilizers of expansive soils in increasing shear strength for both short and long-term performance and cement is more preferable to gain early strength. Lime is the most preferred stabilizer when considering sustainability criteria, whereas cement is the least preferred.

Keywords: Expansive Soil; Shear Strength; Slope Stability; Stabilization; Sustainability

ICSBE25_164

HEAVE OF SUBGRADES STABILIZED OPTIMALLY USING CEMENT, LIME AND FLY ASH

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Abstract: This study investigates the heave characteristics of optimally stabilized expansive soil subgrades using cement, lime and fly ash. The research aims to identify expansive soil characteristics, determine the optimum stabilizer mix proportions of cement, lime and fly ash based on Unconfined Compressive Strength (UCS) of 7-day air-cured samples and evaluate heave characteristics of expansive soils stabilized optimally using the same agents using a laboratory-scale model and compare with an analytical solution. The proposed methodology involves comprehensive soil characterization through various tests, including Atterberg limits, free swell index, Proctor compaction, particle size distribution, UCS and swelling pressure tests. The optimal mix proportions of cement and fly ash were determined using the UCS test, while the optimal lime content was determined through the pH test, targeting a pH value of 12.4 in the lime-soil mixture. The mix of 3% lime, 2.5% cement, and 15% fly ash showed the best results, with a significant reduction in swell potential and improved strength. A laboratory-scale physical model simulated subgrade behavior under variable groundwater levels and the heave predictions using an analytical method were compared with the observed values to validate the model. The study concludes that cement exhibited a minimum optimum UCS value, resulting in the lowest swell compared to lime and fly ash.

Keywords: Chemical Stabilization; Expansive Soils; Heave; Swell Potential

ICSBE25_171

UNSTEADY INERTIAL FLOWS THROUGH FRACTURE INTERSECTIONS: IMPLICATIONS FOR SUBSURFACE RESOURCE RECOVERY

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Abstract: Efficient fluid and particle transportation in fractured geological formations is the basis of most geotechnical and energy applications, such as hydraulic fracturing, geothermal energy extraction, carbon dioxide storage, and subsurface hydrogen transport. Flow mixing and redirection at the fracture intersections play a major role in determining the efficiency of resource recovery and the extent to which injected fluids and particles are distributed within the fractured media. Even though the importance of inertia-driven flows is widely recognised regarding the fracture flows in reservoir engineering applications, their impact on flow behaviour across the fracture intersections is still not fully understood. Due to the inherent difficulty in capturing the highly unsteady flow behaviour in fracture geometries, further challenges to the accurate characterisation of the inertial flows. This study addresses this knowledge gap through controlled laboratory experiments utilising a metre-scale Hele-Shaw fracture model to mimic the flow across a single fracture intersection under a wide range of flow velocities (Re = 800 - 10000) and by characterising the highly time-dependent flow behaviour at the intersection. Time-resolved two-dimensional Particle Tracking Velocimetry (PTV) technique is employed to capture the unsteady flow fields and vortical structures with high spatial and temporal resolution, utilising high-speed imaging. The results reveal that at moderate velocities (transitional Re ≈ 4000 - 6000, where the laminar flow behaviour transforms into turbulent flow), fracture intersections act as amplifiers of flow instabilities, enhancing the mixing at the fracture intersection, an effect that can potentially improve particle placement in fractured formations. With further increment in velocity beyond this moderate flow regime (Re > 8000), flow becomes increasingly momentum-dominated, reducing inflow to the secondary fracture and promoting intermittent, vortex-driven mixing rather than steady diversion. These preliminary findings offer new insight regarding the existence of velocity-dependent inertial thresholds that dictate flow redistribution in fractured formations. Recognising these thresholds is essential for optimising injection strategies, improving particle placement, and enhancing the predictability of resource recovery in geo-energy applications. This work shows that even a single fracture intersection under inertia-driven flow has a substantial impact on the system-scale flow behaviour. Within a complex subsurface fractured formation with many intersections, these effects are likely amplified and more spatially variable. These insights underline the necessity of integrating inertial effects in predictive models used for subsurface operations.

Keywords: Fluid Inertia; Fractures; Hydraulic Fracturing; Particle Tracking Velocimetry (PTV); Subsurface Flow; Unsteady Flow

ICSBE25_185

SUBCRITICAL CRACK PROPAGATION IN CAPROCK: A SYSTEMATIC REVIEW FOR UNDERGROUND HYDROGEN STORAGE

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Abstract: Hydrogen is increasingly being explored as a promising energy carrier to convert and store excess energy generated from renewable sources to use during heightened demand. In this regard, underground hydrogen storage in depleted gas reservoirs is identified as a more viable option compared to other storage methods due to its large storage capacity, existing infrastructure, proven experience in subsurface gas storage such as carbon dioxide sequestration, favourable geological conditions, and cost-effectiveness. These geological formations typically comprise a porous reservoir rock to store injected hydrogen, overlaid by an impermeable caprock that serves as a seal to prevent upward migration. However, caprock formations are constantly subjected to high-pressure operations and geochemical interactions, causing significant changes in the rock's mechanical and microstructural properties. These deformations make the caprock susceptible to multiple crack propagation mechanisms, including stress-induced critical cracks and geochemically induced subcritical cracks. While critical cracks develop abruptly upon exceeding the rock's fracture toughness, subcritical cracks propagate gradually over time under lower stress conditions due to stress corrosion and cyclic loading. It is not immediately detectable, yet may pose a long-term risk and compromise caprock integrity. Thus, it is important to investigate the subcritical cracking mechanism in caprock during underground hydrogen storage. This study presents a comprehensive scientometric review of subcritical crack propagation in caprock during underground hydrogen storage conditions. The findings indicate that existing literature predominantly focuses on geochemical interactions within the hydrogen-rock-brine system, with limited assessment of their impacts on subcritical crack formation. Thus, this paper further proposes a suitable experimental methodology to investigate subcritical crack propagation in caprock for a more accurate assessment of long-term caprock integrity during underground hydrogen storage.

Keywords: Caprock Integrity; Depleted Gas Reservoirs; Double Torsion Method; Subcritical Crack Propagation; Underground Hydrogen Storage

ICSBE25_231

FEASIBILITY OF USING GEOPOLYMER-TREATED EXPANSIVE ROAD SUBGRADE FOR FLEXIBLE PAVEMENT

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Abstract: Expansive soils are highly problematic in construction since they undergo significant volume changes in the presence of moisture, leading to swelling and shrinkage. When flexible pavements are constructed over such soils, they often experience heaving and cracking. Chemical stabilization of expansive soils using suitable binders is a widely used technique to mitigate these issues. This study aims to evaluate the effectiveness of Fly Ash (FA) based Geopolymer (GP) treated expansive subgrades in flexible pavement design, focusing on minimizing surface heave and construction cost. The performance of GP-treated soil was compared with that of Ordinary Portland Cement (OPC)-treated soil. The study involved laboratory testing, such as the 4-day soaked California Bearing Ratio (CBR) test and constant volume swell pressure test. Pavement design was done using the Overseas Road Note 31 guidelines, and heave was estimated using swell pressure and swell percentage values. A cost analysis was done using the prevailing market prices and the Highway Schedule of Rates. The results indicated that both GP and OPC stabilization notably enhanced the properties of the expansive soil. The CBR value increased from 8% to 18% with GP treatment and to 60% with OPC treatment. The swell pressure and swell percentage decreased from 165.9 kPa and 4.6% in the raw soil to 106.9 kPa and 3.3% with OPC treatment, and further reduced to 86.0 kPa and 2.09% with GP stabilization. Pavement thickness reductions ranged from 13%–20% for GP and 30.4%–46.7% for OPC, depending on traffic loading. Additionally, the cost of GP treatment for a treatment depth of 0.3 m is 183% to 301% higher than that of OPC treatment. Overall, flexible pavements constructed on OPC-treated expansive subgrades outperform those treated with GP. Further research is recommended to optimize the mix composition, and sustainable activators should be investigated to improve the effectiveness of geopolymers.

Keywords: Expansive Soil; Flexible Pavements; Geopolymers; Ordinary Portland Cement; Soil Stabilization; Surface Heave

ICSBE25_266

EFFECT OF SILT AND CLAY PERCENTAGE ON LIQUID LIMIT AND PLASTIC LIMIT OF SOME SRI LANKAN SOILS

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Abstract: This study examines the influence of silt and clay percentages on the Liquid Limit (LL) and Plastic Limit (PL) of fine-grained soils collected from various regions in Sri Lanka. Twenty-three inorganic soil samples with low-to-medium plasticity were tested using standardized procedures (ASTM and BS). The samples exhibited LL values ranging from 29% to 48% and PL values from 14% to 30%. Clay content varied between 2.61% and 16.54%, silt content ranged from 2.32% and 9.99% and silt-to-clay ratio ranged from 0.172 to 2.464. One-way ANOVA results demonstrated highly significant effects ($p < 0.05$) of both silt and clay fractions on soil plasticity, with F-statistics exceeding critical values in all cases. Regression analysis revealed that LL versus clay content and silt content were best described by polynomial fits. A clear negative non-linear relationship was observed between LL and the silt-to-clay ratio, suggesting that soils with higher silt-to-clay ratios exhibit lower LL due to the reduced water retention capacity of silt. For PL, correlations were weaker. The best-fit polynomial between PL and silt content yielded $R^2 = 0.1583$, while clay content had minimal predictive power ($R^2 = 0.0285$). LL and PL versus silt-to-clay ratio also showed weak correlations ($R^2 = 0.3713$ and 0.1172, respectively), indicating limited sensitivity of plasticity to fine fraction proportions alone. The relatively weak correlations suggest that factors beyond particle size distribution, particularly the mineralogical composition of clay, may significantly influence plasticity. However, the findings provide fundamental insights into the plasticity behaviour of low to medium-plasticity Sri Lankan soils, and support data-driven approaches to select or modify soils for various geotechnical applications.

Keywords: Liquid Limit; Plastic Limit; Silt-to-clay Ratio; Soil Plasticity; Sri Lankan Soils

ICSBE25_271

INFLUENCE OF PARTICLE GRADATION ON SHEAR BEHAVIOUR OF RAILWAY BALLAST

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Abstract: The ballast layer is a main component in the railway track system. To improve the performance of the track and reduce maintenance costs, it is essential to investigate the shear behaviour and degradation characteristics of ballast under different loading conditions. The mechanical properties of the ballast layer are governed by several factors, such as particle shape, size, gradation, hardness, density, and angularity. Ballast gradation depends on the strength of the parent rock, climatic conditions, subgrade properties, and applied loads. In Sri Lanka, as ballast material, biotite gneiss is used. There is no specific gradation for ballast; rather, gradation limits if Indian standards are used. Also, a few studies were conducted about the effect of particle gradation on the shear behaviour of ballast. Therefore, this study was conducted to investigate the effect of gradations on the shear behaviour of ballast using experimental and numerical analysis. Shear strength parameters were determined by using a large-scale direct shear test. Tests were conducted under three normal stress conditions (30, 60, and 90 kPa). Three different gradations were selected within and around the upper and lower limits of the Indian standard. Furthermore, numerical models were developed using the Discrete Element Method (DEM) to study the shear behaviour of the ballast gradation. Shear stress increased with normal stress increment due to the improved and intensified contact between particles. Generated numerical results showed a good acceptance of experimental results and led to a parametric study with different normal stresses. Ballast breakage analysis shows that the inclusion of the percentage of larger-size particles decreases the breakage. The findings of this study suggest that the presence of larger size particles causes higher friction, therefore an increase in shear strength while reducing ballast particle degradation.

Keywords: Ballast; Degradation; DEM; Gradation; Shear Strength

ICSBE25_272

ASSESSMENT OF INFLUENCE OF PARTICLE SHAPE ON SHEAR BEHAVIOR OF LARGE GRANULAR MATERIALS THROUGH ARTIFICIAL NEURAL NETWORK MODELING

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Abstract: Large-size granular materials play a vital role in geotechnical and railway engineering, where their shear performance is highly dependent on particle shape. However, industry practices often prioritize strength testing while overlooking shape effects, despite their significant influence on interlocking and frictional resistance. This research investigates the influence of particle shape on the shear behavior of large-size granular materials by integrating laboratory testing, Discrete Element Method (DEM) simulations, and Artificial Neural Network (ANN) modeling. Samples collected from the Gampola stockyard were categorized into angular, elongated, and spherical classes based on shape indices such as Elongation Index (EI), Flatness Index (FI), Aspect Ratio (AR), Concavity Index (CI), and Sphericity (S). Particles were scanned using a Qlone 3D scanner and digitized in Fusion360 to generate realistic 3D models. Thirty distinct particle shapes were analyzed through DEM-based direct shear simulations under normal stresses of 30, 60, and 90 kPa, validated against large-scale laboratory direct shear tests. The results demonstrated that elongated particles exhibited the highest average friction angle (67.4°), followed by angular (66.8°), while spherical particles performed the lowest (64.9°). Void ratios remained nearly constant across shapes (0.68–0.72), indicating that enhanced shear resistance is primarily governed by shape-induced interlocking. An ANN prediction model trained on combined DEM and experimental datasets achieved strong predictive performance, with a Root Mean Square Error (RMSE) of 0.1676, while a separate classification model attained accuracies of 91.3% in training and 70.0% in testing. Both models were deployed in a user-friendly web-based application, enabling real-time prediction of shear behavior and shape classification from input parameters. These findings confirm that particle shape is a critical factor in shear performance and provide a practical, computationally efficient framework for material selection and sustainable infrastructure design.

Keywords: Artificial Neural Network (ANN); Discrete Element Method (DEM); Large-size Granular Materials; Particle Shape; Shear Behaviour

ICSBE25_273

EFFECT OF GRIDUSP ON PERFORMANCE OF BALLASTED RAILWAY TRACKS

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Abstract: Ballasted rail track is popular among many railway authorities due to its numerous advantages. However, when faster and heavier trains are accommodated on ballasted tracks, track stability and ballast particle degradation can be identified as two major problems. Researchers have introduced innovative concrete sleeper designs to overcome track instability through improved shear resistance at the sleeper-ballast interface, while the use of Under Sleeper Pads (USPs) attached to the sleeper bottom has been introduced to reduce ballast particle degradation. Meanwhile, a recent study introduced the Grid Under Sleeper Pad (GridUSP), which is attached to the bottom surface of the concrete sleeper to effectively enhance shear resistance at the sleeper bottom while also reducing ballast particle degradation. However, only limited laboratory investigations have been conducted to evaluate the effectiveness of the GridUSP. Hence, its performance under repetitive train loading should be further investigated before field application. Consequently, this study investigates the performance of the GridUSP under cyclic loading. Large-scale cyclic load tests were conducted in the laboratory on a unit cell of a ballasted rail track using a hydraulic dynamic actuator system. The performance of the GridUSP was compared with that of traditional concrete sleepers and USP attached concrete sleepers. The results revealed that the GridUSP is effective in reducing vertical and lateral plastic deformation of ballast. Additionally, the GridUSP reduced ballast particle breakage by about 68% compared to the traditional concrete sleeper. Furthermore, the results revealed that the GridUSP is effective in energy dissipation under dynamic loading conditions, showing a 106% higher strain energy reduction and a 32% higher damping ratio compared to the traditional concrete sleeper sample. The results highlight the effectiveness of the GridUSP in improving track stability, reducing ballast degradation, and enhancing energy dissipation under cyclic loading.

Keywords: Ballasted Track; GridUSP; Large-scale Cyclic Load Test; Sleeper-ballast Interface; Track Performance

ICSBE25_361

USE OF GEOCOMPOSITES TO IMPROVE STIFFNESS AND STRENGTH OF SOFT SUBGRADES

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Abstract: The improvement of soft subgrades is critical in road pavement and working platform construction to facilitate efficient equipment operation, reduce the required thickness of gravel capping layers, and enhance the long-term performance. Conventional techniques such as granular replacement and chemical stabilisation, while effective, are often costly and environmentally unsustainable. Geocomposites, which integrate geogrid and geotextile functions, offer a cost-effective and environmentally preferable solution; yet their stiffness- and strength-enhancement benefits are not fully quantified because systematic research is still limited. This study investigates the role of geocomposites in improving the performance of soft subgrades with a constant CBR of 2.5, using a series of controlled laboratory model tests. Static plate load testing was conducted on unreinforced and geocomposite-stabilised subgrades, with geocomposite placed at the subgrade level. Key performance indicators of strain modulus and Ultimate Bearing Capacity (UBC) were measured and compared. Pressure cells positioned at the subgrade level were used to validate stress transfer and load distribution mechanisms. Results demonstrated that geocomposite reinforcement enhances the strain modulus by approximately 34% and increases UBC by 53% relative to unreinforced subgrades. As strain modulus is a critical parameter in pavement design and UBC is more influential in working platform construction, these findings confirm the dual effectiveness of geocomposites in providing both stiffness and strength improvements, highlighting their potential as a sustainable and practical design solution for weak subgrade conditions in road infrastructure.

Keywords: Geocomposite; Soft Subgrades; Stiffness; Strength

ICSBE25_370

EVALUATING RUTTING PERFORMANCE OF GEOCOMPOSITE - REINFORCED PAVEMENTS USING LARGE-SCALE LABORATORY MODEL BOX TESTING

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Abstract: The long-term performance of unpaved pavements is critically governed by subgrade strength, particularly when constructed over weak or soft soils. Excessive rutting under repeated traffic loading remains a key challenge, often limiting service life and requiring costly maintenance. Geocomposites, geosynthetics that combine the reinforcing function of geogrids with the separation function of geotextiles, have emerged as a sustainable solution to enhance pavement performance by providing aggregate confinement, improving load transfer, and reducing deformation. To replicate realistic in-service conditions, this study employed large-scale laboratory model box testing with cyclic plate loading to simulate traffic-induced stresses. Subgrades of CBR 1.0 and 2.5 were prepared in a 1.0 × 1.0 × 1.2 m test box with a 500 mm subgrade overlain by a 200 mm Type 2.1 gravel capping layer. Each configuration was tested under both unreinforced and geocomposite reinforced conditions until reaching a terminal rut depth of 80 mm or 140,000 cycles. Results demonstrated that geocomposite reinforcement significantly improved rutting resistance, extending pavement life by approximately 170% for CBR 1.0 and 58% for CBR 2.5 at a rut depth of 40 mm. Despite these benefits, pavements founded on weaker CBR 1.0 subgrades still exhibited higher overall rutting compared to stronger subgrades. These findings confirm the effectiveness of geocomposites as a sustainable reinforcement solution for unpaved pavements and highlight the importance of incorporating subgrade strength into design considerations for improved serviceability.

Keywords: Geocomposites; Model Box Testing; Rutting; Unpaved Pavements; Weak Subgrades;

ICSBE25_380

APPLICABILITY OF METHOD OF FRAGMENTS TECHNIQUE FOR COFFERDAMS IN LAYERED ISOTROPIC SOILS

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Abstract: Seepage analysis remains an important task for geotechnical engineers during the construction of hydraulic structures such as cofferdams. The "Method of Fragments" (MoF) is an approximate and semi-analytical method that is simpler and faster to use than other alternatives such as drawing flow nets, analytical solutions, computer simulation and so forth. In this method, the flow domain is divided into "fragments," assuming that the equipotential lines are vertical at these selected points. MoF-based solutions have been developed for many 2D scenarios; however, all of these solutions are defined for only one layer of either isotropic or anisotropic conditions. Therefore, it is unknown whether the Method of Fragments is applicable for multiple soil layers, which are more commonly required to be analysed. The aim of this study is to explore the possibility of extending the Method of Fragments to two isotropic soil layers. To validate the method, the study developed various 2D finite element models of sheet pile cofferdams, varying the excavation depth, the sheet pile depth, and the permeability ratio (k1/k2) between the two soil layers. The models were then compared with the results from the MoF analysis using two parameters: the flow rate q and the exit hydraulic gradient i_E. A key finding was that MoF values are only acceptable to analyse 2D cofferdams when the permeability ratio between the layers is lower than 4. It was also shown that the values of the exit hydraulic gradient given by the MoF analysis were low compared to the actual values, making MoF solutions unsafe. Additionally, the results showed that for higher permeability ratios, the permeability of the bottom layer can be neglected when analysing seepage problems. Overall, the MoF method can be used only for preliminary level estimation of flow rate and exit hydraulic gradient for layered soil systems

Keywords: Cofferdam; Exit Hydraulic Gradient; Flow Rate; Layered Soil System; Method of Fragments

ICSBE25_422

INFLUENCE OF FINES ON STRESS–STRAIN BEHAVIOR AND PARTICLE BREAKAGE OF RAIL BALLAST

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Abstract: Ballasted railway tracks rely on crushed stone ballast as a key structural layer, where shear strength governs track stability, load transfer, and long-term performance. However, ballast fouling caused by the accumulation of fine particles from sources such as wind-blown sand, ballast degradation under cyclic loading, or external contamination alters the inter-particle contact mechanism and compromises shear resistance. This study investigates the influence of fouling type on ballast shear behaviour, focusing on the comparative effects of sand and quarry dust contamination relative to fresh ballast. A series of large-scale direct shear tests was conducted under varying normal stresses to evaluate shear stress–strain response, dilation, and particle breakage characteristics. The results showed distinct differences in fouling effects: quarry dust–fouled ballast exhibited the highest shear strength, primarily due to improved packing density and enhanced particle interlocking provided by the finer quarry dust particles. In contrast, sand fouling reduced shear strength by disrupting interlocking and promoting higher dilation compared to fresh ballast. Nonlinear Mohr–Coulomb shear strength envelopes demonstrated notable variations in peak friction angle: 65° - 74° for fresh ballast, 70° - 78° for quarry dust–fouled ballast, and 61° - 68° for sand–fouled ballast. The Ballast Breakage Index (BBI) increased with applied normal stress for all specimens, reflecting stress-induced particle degradation. However, BBI values for fouled ballast were consistently lower than those for fresh ballast, indicating that fine particles reduce the potential for additional breakage by cushioning contact forces. Overall, the findings highlight that while fouling generally impairs ballast performance, the type of fouling material critically governs the degree and nature of the impact. Quarry dust contamination can lead to a densified ballast matrix with elevated shear strength, whereas sand contamination weakens shear resistance and accelerates deformation. These insights provide valuable implications for track maintenance strategies and fouling management in ballasted railway systems.

Keywords: Ballast; Degradation; Direct Shear Test; Fouling; Shear Stress

ICSBE25_467

PREDICTION OF SETTLEMENT OF SHALLOW FOUNDATIONS USING ARTIFICIAL NEURAL NETWORK (ANN) AND ITS COMPARISON WITH TRADITIONAL METHODS

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Abstract: Prediction of shallow foundation settlement is a critical aspect of geotechnical engineering, as excessive settlement can compromise structural safety and serviceability. Traditional methods often rely on simplifying assumptions that may not capture the complex and nonlinear behavior of soil-structure interactions. Recent developments in Artificial Neural Networks (ANN) present data-driven methods that could enhance predictive precision. However, many existing studies are limited by narrow datasets and complex equations. Therefore, the aim of this research is to develop an ANN model to predict the settlement of shallow foundations on cohesionless soils and to compare its performance against traditional methods. After the outlier removal, a total of 69 datasets were compiled from six different sources. Input parameters used for the ANN model were length-to-width ratio (L/B), embedment ratio (D/B), average SPT blow count (N), net applied load (q_{net}), and foundation width (B); the output was settlement (S). The methodology encompassed data preprocessing, ANN model development using Python, model training and validation, sensitivity analysis to assess variable importance, derivation of an ANN-based empirical equation, and a parametric study to interpret model behaviour. The final ANN model, optimized using Bayesian techniques, achieved high predictive accuracy with an R^2 of 94.9 %, RMSE of 0.518 mm, and MAE of 0.445 mm, significantly outperforming the traditional methods. The ANN-based empirical equation also demonstrated strong performance with an R^2 of 82.2 %. Sensitivity analysis indicated that the SPT value (N) plays the most significant role in influencing settlement when compared to other input parameters. The findings confirm the capability of the ANN model to accurately predict settlement while capturing complex parameter interactions. Future work will aim to derive a simplified ANN-based equation that can provide geotechnical engineers with a practical and reliable tool for making initial settlement predictions in cohesionless soils.

Keywords: ANN; Cohesionless Soil; Sensitivity Analysis; Settlement; Shallow Foundation

ICSBE25_501

EFFECT OF LEACHING OF RESIDUAL SOIL ON THE STABILITY OF SLOPES

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Abstract: Residual soils are common in tropical areas like Sri Lanka. They are very prone to leaching, which removes soluble minerals and harms soil structure. This study looks at how leaching affects the collapsibility and shear strength of residual soils and how this affects slope stability. We used a method that combines experiments and numerical analysis. We took undisturbed soil samples from Gelioya, Sri Lanka, and exposed them to controlled leaching under two hydraulic gradients (8.29 and 15.44). We conducted laboratory tests, including particle size distribution, direct shear, Atterberg limits, and collapse potential tests on both unleached (reference) and leached samples. The results show that leaching leads to a significant loss of fine particles (up to 15-20%), a drop in cohesion (from 61.64 kPa to as low as 50.20 kPa), and an increase in collapse potential. These changes were more noticeable at the higher hydraulic gradient. We used the degraded soil parameters in slope stability models with GeoStudio SLOPE/W software for slopes of different heights (4 m, 8 m, 12 m) and angles (30° to 75°). The numerical analysis showed a steady decrease in the Factor of Safety (FoS) for leached slopes, with higher and steeper slopes being the most at risk. The results highlight that leaching significantly weakens slope stability and increases collapsibility by reducing soil strength.

Keywords: Collapse Potential; Hydraulic Gradient; Leaching; Residual Soils; Shear Strength; Slope Stability

BUILDING AUTOMATION; SMART BUILDING TECHNOLOGIES AND INTELLIGENT INFRASTRUCTURE SYSTEMS

ICSBE25_047

SMART GREEN BUILDING TECHNOLOGIES: A SYSTEMATIC REVIEW OF IOT AND AUTOMATION FOR ENERGY-EFFICIENCY

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Abstract: The necessity to develop cities in a more sustainable way has made the possibility of smart green buildings that incorporate the idea of Internet of Things (IoT), Artificial Intelligence (AI), and automation a priority to achieve the goals of energy efficiency, environmental sustainability, and livability. Although these technologies offer great potential, concerted knowledge of their uses, advantages, and limitations is lacking. This paper is a systematic review of 35 peer-reviewed open-access publications between 2015 and 2025 located in Google Scholar, ScienceDirect, and MDPI using the PRISMA protocol. The review identifies that the myth of IoT-powered automation, involving smart sensors and real-time analytics, maximizes the operation of buildings, especially lighting, heating, ventilation and appliances, by considering occupancy and environmental factors. Interaction between cloud computing and semantic frameworks guarantees scalable and interoperable building management, whereas the application of Internet of Energy (IoE) and smart grid technologies provide two-directional energy trade, demand response, and the ability to integrate renewable energy. Documented results indicated that up to 30% energy saving and huge improvements in CO_2 emission were achieved when compared to the traditional systems. Yet, issues like cybersecurity, the inability to integrate with legacy systems, and not having the standardization are still common. The solutions to these must be cohesive protocols, hybrid systems, and effective cybersecurity tools. New trends, such as Green IoT, AI autonomous control, as well as the digital twin technology, have the potential of transforming energy-efficient smart building design and operation.

Keywords: Artificial Intelligence (AI); Building Automation Systems; Building Energy Efficiency; Digital Twin; Internet of Energy (IoE); Smart Green Buildings

ICSBE25_084

DEVELOPMENT OF AN EXCEL-BASED WHOLE LIFE COST ASSESSMENT TOOL FRAMEWORK FOR BUILDINGS IN SRI LANKA

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Abstract: Sustainable building practices are important for minimizing environmental impacts. Despite the environmental benefits, the construction of sustainable buildings in Sri Lanka is still not prominent. Furthermore, as a signatory to the Paris Agreement, Sri Lanka should achieve net-zero carbon buildings by 2050. The main constraint for sustainable buildings is that the initial costs overshadowing the long-term benefits. Since Sri Lanka is a developing country, investors focus on financial benefits prior to environmental. The long-term financial benefits of sustainable buildings can be demonstrated by a Whole Life Cost (WLC) analysis. But their adoption in Sri Lanka remains limited due to a lack of locally relevant tools, inadequate data and insufficient awareness. This paper aims to develop an Excel-based WLC assessment tool framework for buildings in Sri Lanka. The tool is designed to be user-friendly, adaptable and to comply with international standards. A comprehensive review of global WLC/Life Cycle Cost (LCC) tools was conducted and their frameworks, standards used, and scope were studied. The proposed tool incorporates the ISO15686-5 standard for the WLC framework, and expert consultation was taken for customization to Sri Lankan requirements. This paper provides the mathematical framework for the Excel tool development. The resulting framework consists of non-construction costs, income, construction, operation, and maintenance costs. The calculation of WLC involves the summation of all these costs and discounting for the present value to account for the time value of money. The user has the freedom to select the system boundary for the analysis according to the requirement, facilitating better financial decision-making. Further development of this framework will focus on integrating the same with the whole building environmental life cycle assessment tool and enhancing the industry applications of sustainable construction.

Keywords: Building Sustainability; Decision Support; Life Cycle Costing; Tool Framework; Whole Life Cost

ICSBE25_115

DEVELOPMENT OF A WEB-BASED INTELLIGENT MAINTENANCE /MANAGEMENT SYSTEM FOR ENHANCED SAFETY AND TECHNICIAN RECOMMENDATION IN MANUFACTURING

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Abstract: The integration of intelligent maintenance and safety management systems has become increasingly important in the manufacturing field. We propose a web-based intelligent maintenance management system that integrates building safety data and employee profiles, basically their competencies, experiences and safe work practices records to enhance technician assignment and safety compliance. In every workplace where there is a safety management system, definitely there should have a competency matrix to evaluate the proven experiences of the particular personnel. Competency of the technicians is an administrative control method under the control of hierarchy, which is used as a proactive approach to mitigate the identified risk and prevent accidents during a work done. Through Flask, Pandas, and Excel datasets, the system compares safety grades, hazard types, and competency of the technicians to suggest the most suitable personnel to perform the specific maintenance work. The device ensures safe and efficient maintenance by considering real-time safety constraints and the technician's competence. Tests validated the accuracy and usability of the system, thereby justifying its potential to reduce operation-related risks, enhance safety culture, and streamline maintenance processes and increase efficiency and productivity in the manufacturing industry. This integration will help to prevent the unsafe acts and near-misses which reported in the workplaces.

Keywords: Industrial Safety; Maintenance Optimization; Predictive Maintenance; Safety Management; Technician Recommendation; Web-based System

ICSBE25_150

LEVERAGING DIGITAL TECHNOLOGIES FOR ENHANCING CITY INFORMATION MODELLING

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Abstract: The increasing complexity of urban systems necessitates advanced digital solutions for sustainable management, with City Information Modelling (CIM) emerging as a transformative approach. Yet, existing research predominantly examines CIM in isolation, lacking a systematic synthesis of how digital technologies can enhance its frameworks, including current trends, synergies, and implementation challenges. This study addresses this gap by conducting a two-phase analysis: (1) A quantitative analysis using PRISMA to understand publication trends across Scopus and Web of Science analysing 557 papers, illustrating temporal patterns, adoption rates and key publications; and (2) A qualitative analysis of 114 selected papers to define CIM, identify key features, evaluate nexus between digital technologies and CIM, implementation challenges and future directions. Findings highlighted a growing interest in CIM since 2019, dominated by key themes such as smart cities, Geographic Information Systems (GIS), information management, while revealing disparities in regional adoption saturated in China, the United Kingdom, the United States, Italy and Australia. The qualitative synthesis distinguishes CIM from 3D modelling and smart cities, defines its key features, and establishes a process protocol for CIM implementation. Findings further elaborated on the practical applications of CIM for urban systems such as urban planning, circular economy, energy and disaster management, analysed the nexus between CIM and digital technologies such as Digital Twins (DT), Internet of Things (IoT), and blockchain and identified critical implementation challenges (i.e., interoperability, security, legal, governance, etc.). The study's key contributions include: (1) a collective CIM definition clarifying conceptual boundaries, (2) a process-driven protocol for CIM deployment, and (3) future research priorities addressing gaps such as scalability and performance optimisation, enhanced interoperability and cross-stakeholder collaboration models. Practical recommendations emphasise standardisation, governance frameworks, and pilot scalability to transition CIM from theory to urban practice.

Keywords: City Information Modelling (CIM); Digital Technologies; PRISMA; Systematic Review; Urban Management

ICSBE25_460

A KANSEI ENGINEERING APPROACH TO COMPARING USER ENGAGEMENT WITH 2D AND 3D WEB HERO SECTIONS

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Abstract: Web designers are increasingly faced with the challenge of choosing between 2D and 3D graphics to maximize user engagement, but there is a limited quantity of research that systematically compares their cognitive and emotional effects. This research study fills this gap by exploring the effects of 2D and 3D hero section designs on user ratings of clarity, professionalism, immersion, excitement, as well as engagement. The research applied a Kansei Engineering (KE) framework to assess emotional responses and used Principal Component Analysis for data reduction and identification of data factors. A total of 100 participants rated twenty hero section prototypes as ten 2D and ten 3D, across ten thematic contexts. Ratings were obtained using a 5-point Likert-type scale, which permitted descriptive and multivariate statistical analysis. Two significant factors were derived from the analysis: cognitive–professional attributes (clarity and professionalism) with a stronger association to the 2D designs, and affective–emotional attributes (immersion and excitement) with a stronger association to the 3D designs. The findings indicated that the 3D prototypes outscored the 2D prototypes on immersion, excitement and engagement overall mean score of over 4.5/5; preferred among 65% of the participants. The 2D prototypes, on the other hand, had a higher mean score on clarity, simplicity, and professionalism means between 3.2 and 3.9, with around 30% of participants preferring 2D designs in professional or trust-sensitive contexts. The results demonstrate that there is no one design style that fits all solutions to achieve optimal engagement with digital prototypes in either 2D or 3D. A hybrid solution of 2D: clarity and professionalism and 3D: immersive qualities provides the best overall solution. This research extends the application of KE in web interface design, provides empirical evidence in the 2D vs. 3D graphic debate, and provides clear guidance for designers and businesses to enhance engagement in digital contexts.

Keywords: 2D Graphics; 3D Graphics; Kansei Engineering; Principal Component Analysis; User Engagement; Web Design

SUSTAINABLE MATERIALS

ICSBE25_023

DESIGN OF AN ECO-FRIENDLY PARTITION WALL PANEL USING GLASS WASTE

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Abstract: Given that solid waste is a critical global environmental concern, this addresses the crisis of Waste Glass (WG) disposal in Sri Lanka by investigating, potential for manufacturing an eco-friendly partition wall panel using discarded automotive materials. This research employed a mixed-methods approach, beginning with a quantitative survey in the Colombo district to establish the waste generation profile, revealing that local garages generate an estimated 100 to 300 kilograms of WG per month, primarily from damaged front windscreens. This highlights the critical need for better waste management, given the inefficient recycling. The core of the research involved designing and testing concrete-based partition panels, compliant with BS5234-1:1192, where finely crushed WG was utilized as a coarse aggregate replacement at varying proportions: 10%, 20%, and 30%. The laboratory testing, including the Compressive Strength Test (CST), Thermal Conductivity Test (TCT), and Fire Resistance Test (FRT), was performed to validate the performance of the prototype panels against industry standards. The comprehensive analysis of the mechanical properties demonstrated that all three mixed proportions successfully met the minimum characteristic strength requirements for non-load-bearing partition elements. Critically, the 10% WG replacement mixture consistently yielded the highest compressive strength value across 7-, 14-, and 28-day curing periods. Further performance evaluation showed that the optimized 10% WG panel exhibited favourable low thermal conductivity and delivered good fire resistance properties, establishing it as the most suitable mixed proportion. In addition to superior structural and thermal performance, a comparative cost analysis confirmed that the designed WG panel is more cost-effective to produce than traditional walling elements. The non-load-bearing panel is recommended for both residential and lightweight commercial interior applications. This study successfully validates a sustainable and economically compelling solution for managing automotive glass waste, thereby promoting resource conservation and enhancing the use of eco-friendly materials within the Sri Lankan construction industry.

Keywords: Concrete; Partition Panel; Waste Glass; Waste Management

ICSBE25_026

FEASIBILITY OF ALUM SLUDGE INCORPORATED TERNARY BLEND WITH METAKAOLIN IN CEMENT MORTARS

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Abstract: Cement production is a major source of global carbon dioxide (CO_2) emissions, contributing approximately 7-8% of total anthropogenic emissions due to the calcination of limestone and the energy-intensive clinker manufacturing process. Concurrently, the disposal of alum sludge, a byproduct of drinking water treatment plants, poses environmental challenges, often leading to landfill accumulation. Addressing these issues via integration of circular economy principles, this study explored the potential of calcined Alum Sludge (AS) as a Supplementary Cementitious Material (SCM) when used in combination with Metakaolin (MK) for partial cement replacement in mortar. Alum sludge was thermally treated at 800 °C to enhance its pozzolanic reactivity. X-ray Diffraction (XRD) analysis revealed that AS consists predominantly of an amorphous phase, with calcination promoting the formation of reactive alumina and silica polymorphs. Mortar mixes incorporating 20% cement replacement using a 1:1 blend of AS800 and MK achieved 93.6% of the 28-day compressive strength of the control mix. This strength development is attributed to the synergistic formation of additional calcium silicate hydrate (C-S-H) and calcium aluminosilicate hydrate (C-A-S-H) phases and potentially due to enhanced microstructure and pore filling effect of finer metakaolin particles. This suggests the synergic influence of SCMs in the strength development of mortar samples.

Keywords: Compressive Strength; Drinking Water Treatment Sludge; Metakaolin; Mortar; Supplementary Cementitious Material

ICSBE25_029

WATER HYACINTH (*Eichhornia crassipes*)-DERIVED CELLULOSE NANOFIBERS: ISOLATION AND CHARACTERIZATION FOR ADVANCED MATERIAL APPLICATIONS

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Abstract: Water Hyacinth-WH (*Eichhornia crassipes*), considered an invasive aquatic plant, contributes to a significant environmental challenge due to its rapid proliferation and substantial damage to the ecosystem. Nevertheless, the high availability of cellulose offers an opportunity for this plant for sustainable valorization to become a high-value material. This research study focuses on the extraction of Cellulose Nanofibers (CNFs) from WH and the development of CNFs-based hydrogel, which can be utilized to fabricate CNFs thin films for fruit and vegetable packaging. Cellulose was isolated from WH biomass, optimizing a combination of mechanical and chemical treatment protocols, including dewaxing, acid hydrolysis, alkali, and bleaching processes, followed by grinding and ultrasonication as mechanical fibrillation to obtain nanofibers. The resulting pulps in each processing step were characterized using colour profile parameter analysis, X-ray Diffraction (XRD), and Thermogravimetric Analysis (TGA) to confirm the gradual purification, crystallinity index, and thermal stability. The stability of the CNFs dispersion was evaluated by Zeta-potential analysis. The treatment process significantly increased both the cellulose purity and the Crystallinity Index (C_I) of the CNFs, leading to improved thermal stability and performance. These outcomes underscore the potency of treated CNFs for advanced applications in high-performance materials. More specifically, the TGA resulted in a 17.1% higher weight loss in the treated CNFs, effectively enhancing the cellulose purity, and leading to improved thermal behaviour and stability. For the CNFs dispersion, the highest Zeta-potential was obtained in pH-7 as -26.8 mV and a significant difference ($p < 0.05$) in L*, a*, and b* values were recorded for the pulps obtained in different processing steps. Concluding the remarks of the study, the utilization of CNFs obtained from WH with remarkable mechanical, thermal and biological potency opens new avenues for sustainable materials, fostering circular economy practices.

Keywords: Cellulose; Characterization; Hydrogels; Nanofibers; Water Hyacinth

ICSBE25_031

WOOD IDENTIFICATION STUDY FOR AFRICAN MAHOGANY (*Khaya senegalensis*), NARROW LEAF MAHOGANY (*Swietenia mahogani*) AND BROAD LEAF MAHOGANY *(Swietenia marophylla)*

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Abstract: Wood anatomy plays a significant role in wood identification and the forestry research sector. Broad-leaf Mahogany, Narrow-leaf Mahogany and African-Mahogany species are important timber species of the Meliaceae family, available in Sri Lanka. Wood colour, density and external appearance of those sawn wood are homogeneous. Hence, it is difficult to identify sawn timber planks of these three species separately. Timber Identification is a highly important task to confirm its authenticity for proper timber use. Lesser-known timber species are coming to the present market today. As consumers are not able to identify timber species correctly, they tend to get misled easily. Wood anatomy is considered to be a precise and rapid method for wood identification. The present practice of timber identification is mainly based on external appearance, and there is no proper, precise identification mechanism in Sri Lanka. In this research, three species were identified by wood anatomical features and distinguished by microscopic examination of wood. Authentic timber samples were collected from the Research Division of the State Timber Corporation (STC), and transverse, radial, and tangential sections at a thickness of 10-15 micrometers were cut using a sledge microtome (Model Leica SM2000 R). Measurements were obtained using Micrometrics SE Premium 4 software available at the Wood laboratory, Research Division of the STC, Sri Lanka. Broad Leaf Mahogany and Narrow Leaf Mahogany show uniseriate rays, but African mahogany shows Mutiseriate rays only. The vessels number per mm^2 is generally within the range of 5 to 20 in African Mahogany and low in Broad Leaf Mahogany and Narrow Leaf Mahogany (< = 5). Mean ray width is high in Broad Leaf Mahogany (68.22 µm) and African Mahogany (85.66 µm), while Mean ray width is relatively low in Narrow Leaf Mahogany (43 µm). The average fiber length of Broad Leaf Mahogany is 1426.9 µm. Average fiber length of Narrow Leaf Mahogany and African Mahogany is below 1600 µm. Runkel ratio is relatively high in African Mahogany. According to the present study, Broad leaf Mahogany, Narrow leaf Mahogany and African Mahogany timber species could be identified by wood anatomical features.

Keywords: Broad- leaf Mahogany; Identification; Narrow -leaf Mahogany; Wood Anatomy

ICSBE25_036

EFFECT OF ELEVATED TEMPERATURES ON PHYSICAL AND MECHANICAL BEHAVIOR OF SAWDUST-ENHANCED CEMENT MORTAR

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Abstract: This experimental study explores the effect of elevated temperatures on the physical and mechanical behaviour of cement mortar partially enhanced with sawdust, an abundant byproduct from the timber industry. In pursuit of sustainable construction solutions, sawdust was introduced as a partial replacement for fine aggregate at varying levels (0%, 3%, 6%, 10%, 20%, and 30% by mass). All mortar mixes maintained a cement-to-sand ratio of 1:2 and a water-cement ratio of 0.5. Standard specimens were cast and cured for 28 days before being exposed to elevated temperatures of 100 °C, 200 °C, 400 °C, 600 °C, and 800 °C to simulate fire conditions. Mass loss, porosity, density, compressive strength, and flexural strength were measured to assess the material's thermal response. The findings revealed a consistent trend of increasing mass loss and porosity with higher sawdust content and temperature, primarily attributed to moisture evaporation and the degradation of organic matter. Density decreased across all mixes with elevated temperature and increased sawdust content. While low percentages of sawdust (≤10%) maintained acceptable compressive and flexural strengths up to 400 °C, higher contents (20 – 30%) led to significant structural degradation and even disintegration beyond 600 °C. At room temperature, the control mix recorded 21.01 MPa compressive strength, which dropped to 3.19 MPa in the 30% sawdust mix. Similar reductions were observed in flexural strength. These results highlight that although sawdust inclusion offers environmental and weight reduction benefits, its use in thermally exposed structural applications must be limited. The study concludes that sawdust can be effectively utilized up to 10% replacement for non-load-bearing or protected environments, supporting circular economy principles in construction. The findings contribute valuable insights for the development of eco-friendly cementitious materials resilient under moderate thermal exposure.

Keywords: Compressive Strength; Elevated Temperature; Flexural Capacity; Mortar; Sawdust; Sustainability

ICSBE25_058

STUDY ON THE BIODEGRADABILITY OF POLYLACTIC ACID-BASED TEA BAGS UNDER SIMULATED ENVIRONMENTAL CONDITIONS

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Abstract: To combat the issue of plastic waste, manufacturers of tea bags are substituting the petrochemical-plastic component of the product with a bio-based Plastic Polylactic Acid (PLA), due to its excellent biocompatibility, decent transparency, and high tensile strength and elasticity. The aim of the research study is to estimate the extent to which bioplastic tea bags can biodegrade under simulated environmental conditions using five different soil conditions with elevated (60 ℃) and ambient (28 ℃) temperatures. The percentage mass deterioration of polymer materials was examined following burial (10 cm depth) in soil conditions for 4 months. Analytical techniques, including mass loss measurements and Fourier-Transform Infrared Spectroscopy (FTIR), were employed to monitor structural and chemical changes in PLA tea bags over time. The highest percentage of mass loss (42.01 ± 23.10 %) was recorded for Teabag A (GM corn-based PLA mesh - OHKI CO.LTD) under the elevated compost soil condition. The lowest percentage of mass loss of 2.64 ± 1.19% was observed for Teabag C (Non-GM sugar cane-based PLA mesh - OHKI CO.LTD) under the ambient sand soil condition. Morphological changes of the polymer materials were determined using SEM, where the surface and fiber deterioration were identified visually. FTIR experiments identified notable chemical transformations, including shifts in existing peaks and intensity changes, suggesting oxidation and hydrolysis of the PLA structure. These findings indicate that PLA-based tea bags undergo biodegradation under simulated conditions, though the rate and extent of degradation are influenced by environmental factors such as moisture, microbial activity, and temperature.

Keywords: Biodegradability; Biopolymer; FTIR; Polylactic Acid (PLA); SEM; Sustainable Packaging.

ICSBE25_064

SCALABLE SUPERHYDROPHOBIC COATING FOR BAMBOO: ENHANCING DURABILITY, WATER REPELLENCY, AND SELF-CLEANING ABILITY FOR SUSTAINABLE APPLICATIONS

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Abstract: The global shift toward sustainable material alternatives has heightened interest in bamboo as a replacement for petroleum-based plastics in construction, packaging, and consumer goods. Owing to its rapid growth, renewability, and mechanical strength, bamboo is an ideal candidate for eco-conscious applications. However, its inherent hydrophilicity and vulnerability to moisture severely limit its use in outdoor and high-humidity environments. In this study, we present a scalable and efficient surface engineering approach to transform bamboo into a superhydrophobic, self-cleaning material with enhanced environmental durability. A transparent sol-gel coating was developed using tetraethyl orthosilicate (TEOS) and 1H,1H,2H,2H-perfluorooctyltriethoxysilane (PFOTES), a fluorinated silane known for its strong surface energy reduction capabilities. The coating was applied via a simple brush-coating method onto sandpaper-treated bamboo, producing a nano-micro hierarchical surface. This morphology, formed by randomly deposited PFOTES-modified SiO_2 nanoparticles aggregating into micro-nano structures, is critical for achieving long-lasting superhydrophobicity. The modified bamboo demonstrated excellent water repellency, with a static water contact angle of 163° ± 2° and a sliding angle of 7° ± 0.5°, enabling rapid droplet roll-off. The coating exhibited strong abrasion resistance, maintaining superhydrophobic performance after 100 cycles of sandpaper wear. It also showed high chemical stability across a broad pH range (1 - 11) and retained hydrophobic properties after immersion in both hot (100 °C) and cold (10 °C) water. Furthermore, the surface effectively repelled a wide range of contaminants, including mud, sauces, and beverages, demonstrating superior self-cleaning capabilities. This work offers a robust and practical strategy for enhancing the surface functionality of bamboo, addressing its primary limitations while preserving its sustainability advantages. The resulting material combines water repellency, chemical resilience, self-cleaning performance, and mechanical robustness, making it a strong candidate for high-performance applications in outdoor furniture, building materials, and environmentally responsible packaging.

Keywords: 1H,1H,2H,2H-perfluorooctyltriethoxysilane; Self-cleaning; Superhydrophobic Bamboo; Tetraethyl Orthosilicate;

ICSBE25_082

GLYCINE INTERCALATED Mg/Al LAYERED DOUBLE HYDROXIDES NANODRUG DELIVERY SYSTEM FOR CONTROLLED RELEASE APPLICATIONS

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Abstract: Glycine is an essential amino acid used in pharmaceuticals as well as in nutraceuticals. But its rapid dissolution and lack of sustained release limit its effectiveness. Layered Double Hydroxides (LDHs) have been extensively studied as drug delivery systems due to their favourable characteristics, including biocompatibility, high loading efficiency, and pH-responsive release. However, previous studies involving glycine in LDH systems with a detailed study on its release behaviour are limited. This research is focused on enhancing the stability and controlled release of glycine by intercalating it into LDHs. Commercially available Mg/Al-CO_3 LDH was modified via ion exchange to obtain Mg/Al-NO_3 LDH that has a higher ion exchange capacity. Then, glycine was intercalated into the modified LDHs. The synthesized glycine-LDH nanocomposite was characterized using SEM, FTIR, PXRD and TGA for confirmation of successful intercalation and assessment of structural as well as thermal properties of the drug composite. PXRD revealed increased interlayer spacing, indicating successful intercalation, while FTIR and TGA further confirmed the presence of functional groups and thermal behaviour of the drug composite. SEM images revealed a characteristic LDH structure supporting successful intercalation without structural change. The encapsulation efficiency of glycine in the LDH was calculated to be 55%. Currently, the work focuses on determining the pH-dependent release profiles of glycine using UV-Vis spectroscopy in three pH media that simulate the human gastrointestinal environment. The present research emphasizes the prospects of LDH-based systems for controlled glycine release with the goal of improving therapeutic efficacy and reducing the frequency of dosing.

Keywords: Controlled Release; Encapsulation Efficiency; Glycine; Ion-exchange; Mg/Al LDHs

ICSBE25_083

ANTHRANILIC ACID INTERCALATED Mg/Al LDHS NANODELIVERY SYSTEMS FOR CONTROLLED RELEASE APPLICATIONS

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Abstract: Anthranilic Acid (AA) is a precursor for various pharmaceutical compounds and an intermediate found in the human metabolic pathway. Due to its limited therapeutic activity, it is commonly incorporated into drug formulations in hybrid forms. Layered Double Hydroxides (LDHs) serve as promising nano vehicles that can potentially protect and carry the drugs to target sites, thereby addressing the major challenges of conventional drug delivery systems. However, previous studies involving AA in LDH systems are limited and lack comprehensive insight into the resulting properties. In this study, commercially available Mg-Al LDHs were modified, and AA was intercalated into the material via ion exchange. The resulting nanocomposite was characterized using PXRD, SEM, FTIR and TGA analytical techniques. Analyses of the FTIR and TGA spectra confirmed the exchange of interlayer ions in the modified nanomaterial, resulting in increased interlayer space for drug loading. PXRD analysis confirmed the successful intercalation of AA, as evidenced by increases in the interlayer spacings of LDHs. SEM images revealed corresponding morphological changes and a layered structure characteristic of LDH materials. Furthermore, FTIR and TGA analyses validated the presence of characteristic functional groups and thermal transitions. The encapsulation efficiency was also calculated using UV-Vis spectrophotometry. The release behaviour of the nanocomposite was tested in three different pH media, simulating the gastrointestinal environment of the human body. A controlled and gradual release of the intercalated AA was observed in all three media. Based on these findings, LDH-AA could be proposed as a promising nano candidate for the advancement of drug delivery applications.

Keywords: Anthranilic Acid; Controlled Release; Encapsulation Efficiency; Intercalation; Mg-Al LDHs; Nano Drug

ICSBE25_110

ENHANCING NANOFLUID STABILITY AND HEAT TRANSFER PERFORMANCE USING Ag/TiO_2 AND Cu/TiO_2 HYBRID NANOPARTICLES.

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Abstract: Hybrid nanofluids are gaining attention as effective mediums for enhanced heat transfer. However, challenges such as sedimentation, particle agglomeration, and stability loss under thermal cycling limit their practical application. To address these issues, this study focuses on developing stable hybrid nanofluids using Ag-doped TiO_2 and Cu-doped TiO_2 nanoparticles. During this study, hybrid nanoparticles were synthesized via metal doping and characterized using FTIR, TGA, SEM, and UV-Vis spectroscopy to confirm successful incorporation of Ag and Cu into the TiO_2 matrix. Nanofluids were dispersed in water, and stabilized with Polyethylene Glycol (PEG), Cetyltrimethylammonium Bromide (CTAB), and Sodium Lauryl Sulfate (SLS), used individually and in combinations. pH adjustment with sodium citrate further improved colloidal stability, with PEG + SLS performing best in the pH range 9.5 –1 0. Maximum stable concentrations were 200 ppm under stagnant conditions and up to 225 ppm (Cu/TiO_2) and 200 ppm (Ag/TiO_2) under dynamic conditions. FTIR, TGA, SEM, and UV-Vis confirmed successful doping and dispersion. Absorbance measurements showed significant stability improvements: Cu–TiO_2 with PEG + SLS rose from 2.958 to 3.887, while Ag–TiO_2 with PEG increased from 0.900 to 3.400 at pH 9.5 – 10. A double-tube heat exchanger test revealed that both nanofluids outperformed the base fluid, with Cu/TiO_2 showing higher efficiency. At 250 ppm, Cu/TiO_2 improved the heat transfer coefficient, overall coefficient, and heat transfer rate by 34.40%, 21.34%, and 7.63%, respectively, compared to 20.99%, 17.48%, and 4.54% for Ag/TiO_2. Higher concentrations caused sedimentation, restricting applicability. Overall, Cu/TiO_2 stabilized with PEG + SLS at optimized pH showed the best stability and thermal performance, highlighting its potential for industrial heat transfer systems.

Keywords: Ag/TiO_2; Cu/TiO_2; Heat Transfer; Hybrid Nanofluids; Nanofluid Stability; pH Adjustment

ICSBE25_137

PARTICLE SIZE OPTIMIZATION OF WASTE-DERIVED SILICATES FOR ENHANCED REACTIVITY IN SUSTAINABLE GEOPOLYMER BINDERS

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Abstract: The reactivity of waste-derived silicate materials used as precursors in geopolymer technology is strongly influenced by their particle size distribution and specific surface area, both of which govern dissolution behavior in alkaline environments. In this study, mechanical grinding was applied to refine the physical characteristics of three silicate wastes named glass cullet, rice husk ash, and silica fume and the resulting modifications were systematically characterized. The raw materials were ground for durations of one, two, and three hours, followed by comprehensive particle size and surface area analyses using master size analysis with laser diffraction. Significant material-specific trends were observed. Rice husk ash, initially extremely coarse, demonstrated the most pronounced transformation, with the median particle size reduced from 390 µm to 8.68 µm and the specific surface area increased from 24 m^2/kg to 949 m^2/kg after three hours of grinding. The fine fraction (< 10 µm) rose to 55%, indicating substantial enhancement in potential reactivity. Glass cullet exhibited moderate improvements, with median particle size decreasing from 198 µm to 16.7 µm and specific surface area rising tenfold to 600 m^2/kg, while silica fume displayed only marginal gains due to its already fine initial state and tendency toward agglomeration. Parametric correlations confirmed a strong inverse relationship between particle size reduction and specific surface area, as well as between particle fineness and the proportion of highly reactive fractions. These findings highlight that after extended grinding, rice husk ash emerges as the most promising precursor for high-performance sustainable geopolymer activators, glass cullet remains a viable secondary option, and silica fume may require alternative activation strategies beyond mechanical milling. The study underscores the critical role of particle size engineering in valorizing agricultural and industrial silicate wastes for next-generation sustainable binder systems.

Keywords: Alkali Activation Reactivity; Geopolymer Technology; Mechanical Grinding; Particle Size Distribution; Specific Surface Area; Waste-derived Silicates

ICSBE25_163

OPTIMAL SUGAR DOSAGE FOR INITIAL SETTING TIME AND MECHANICAL PROPERTIES OF CONCRETE

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Abstract: This paper presents an investigation into the use of sugar as a sustainable, natural, and economical retarding admixture in concrete, with an emphasis on its effects on initial setting time, workability, compressive strength, and tensile strength. Experimental tests were carried out on C25 and C40 concrete mixes with various dosages of sugar from 0.04% to 0.10% by weight of cement, whereas commercial retarders like ADCRETE HR and BettoPlast 64 were used as reference specimens. The results showed that 0.06% was the most effective dosage, which extended the initial setting time of the control mix by some 75 minutes and retained more than 95% of the 28-day compressive strength. However, dosages higher than 0.08% resulted in premature acceleration and loss of strength due to modified hydration kinetics. In comparison with commercial retarders, sugar achieved similar improvements in workability at nearly one order of magnitude lower cost, underlining its economic and ecological benefit. The current study is one of the limited number that quantitatively establish the optimal dosage range of sugar for retardation in concrete, offering a new and sustainable route toward reducing reliance on chemical admixture applications during hot-weather concreting.

Keywords: Compressive Strength; Concrete Retarder; Initial Setting Time; Sugar Admixture; Sustainable Construction Materials; Tensile Strength

ICSBE25_166

EVALUATING THE IMPACT OF WASTE GLASS POWDER CEMENT REPLACEMENT ON THE EMBODIED CARBON OF BRIDGES

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Abstract: Construction of bridges is a major source of global carbon emissions, primarily because of the extensive use of concrete, which includes cement, which is the most carbon-intensive constituent in concrete. In order to reduce the environmental impact, this study examines the use of Waste Glass Powder (WGP) as a substitute for cement. The objective of this study is to evaluate the potential reduction in embodied carbon in bridge deck construction by substituting WGP for a portion of Ordinary Portland Cement (OPC). The environmental effects of several concrete mix designs have been estimated and compared using a theoretical approach that relied on secondary data from the literature. Literature evidence suggests that WGP (particle size 45-75 µm) enhances compressive strength at 10-15% replacement levels because of pozzolanic reactions, but strength reduces at higher percentages. Carbon saving calculations based on ICE database parameters indicate 4.40-19.10% savings, with better-quality mixes like C35/45 resulting in greater absolute savings and poorer-quality mixes like C16/20 giving maximum relative savings. In a 20-meter bridge deck design case study, a saving of 200 $kgCO_2$ per metre was achieved through the use of 10% WGP substitution, satisfying BS 5400 performance requirements. Besides lowering the requirement of cement and recycling waste glass, WGP supports the circular economy. Even though the energy required to produce WGP and aggregate uncertainty are not taken into consideration in this study, the case study shows that using WGP can lower embodied carbon by about 19.6%, indicating its potential to contribute to environmental sustainability.

Keywords: Carbon Emissions; Compressive Strength; Concrete Mix Designs; Ordinary Portland Cement; Waste Glass Powder

ICSBE25_179

SYNTHESIS AND CHARACTERIZATION OF SUSTAINABLE PAPER MATERIAL FROM LEAF STALK FIBER WASTE OF *Borrasus flabellifer L.*

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Abstract: The leaf stalk of Palmyrah (*Borassus flabellifer L.*) is traditionally used to produce hard fibers for manufacturing heavy-duty brushes, particularly for marine ship cleaning. However, this process generates substantial fiber waste, which is typically discarded in landfills, posing environmental and health concerns. This study aims to convert Palmyrah Leaf Stalk Fiber (PLSF) into a sustainable paper material. Initially, the PLSF was soaked in water for two days and then subjected to separate chemical treatments: alkali treatment using NaOH and bleaching treatment using H_2O_2, each in varying concentrations (T1 = 5% NaOH, 3% H_2O_2; T2 = 5% NaOH, 5% H_2O_2; T3 = 10% NaOH, 3% H_2O_2; T4 = 10% NaOH, 5% H_2O_2) at 60 °C for 45 minutes to remove impurities and bleach the fibers. The treated fibers were characterized using FTIR spectroscopy. FTIR characterization of treated PLSF depicted that the fibers were successfully treated, confirming the removal of non-cellulosic components. Paper pulp was prepared by mixing water with each treated PLSF sample, and 0.2% gelatin was added as a binding agent. Handmade paper was produced using a screening mesh. The physical and chemical properties of the resulting papers—such as tensile strength, thickness, balanced grammage, total ash content, moisture content, opacity, and pH were evaluated using standard analytical methods. Among the four samples, Sample T3 demonstrated the best overall performance, exhibiting the highest tensile strength (1.51×10^{-3} MPa), thickness (0.051 mm), balanced grammage (96.47 grams per square meter- gsm), total ash content (9.62%), moisture content (13.31%), acceptable opacity (85%), and acceptable pH (7.15) and making it the most promising candidate for quality paper applications. This study presents a sustainable approach to waste valorization, adding value to the Palmyrah industry. Future work should focus on enhancing paper quality through the use of advanced technologies.

Keywords: Bleaching; Palmyrah; Paper; Stalk Fibre; Sustainable

ICSBE25_183

A PRELIMINARY STUDY OF MICROBIOLOGICALLY-DRIVEN, SUSTAINABLE PROCESS FOR THE EXTRACTION OF RARE EARTH ELEMENTS FROM SRI LANKAN APATITE ORE

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Abstract: Rare Earth Elements (REEs) are essential for numerous technologies, yet their extraction remains challenging and environmentally intensive. This study explores a sustainable and eco-friendly process for extracting REEs from apatite ores, conducted using the light-REE-rich rock phosphate soil in Eppawala, Sri Lanka, and investigates specific microbial strains capable of bioleaching REEs, providing a process to reduce the use of strong acids and bases, high energy consumption and waste production in traditional REE recovery approaches. Using Phosphate-solubilizing Microorganisms (PSMs) isolated from Eppawala Rock Phosphate (ERP) soil, specifically with a selected one bacterial and one fungal species, bioleaching experiments were conducted with controls. Periodic measurements of pH, solubilized-phosphate content using UV-VIS spectroscopy and REE concentration using ICP-OES analysis were taken. Results indicated a significant increase in REE leaching from the soil samples exposed to both bacterial and fungal species compared to controls. Using sterilized ERP soil ($\leq 62\ \mu m$) and Pikovskaya's broth at 1% pulp density, the experiment started with an initial pH of 4.49. In the control sample, total leached REE concentrations and the pH values remained fairly constant, recovering 0.5 ppm on day seven and 1.0 ppm on day 28, along with pH values of 4.48 and 4.31. For the bacterium isolate (Gram-positive rod-shaped spore-former), total leached REE concentrations decreased gradually: 9.2 ppm on day 7, 6.4 ppm on day 14, and 4.4 ppm on day 21, obtaining relatively stable pH values of 3.07, 3.12, and 3.32. For the fungal isolate (filamentous spore-former), total leached REE concentrations showed an increasing trend: 2.0 ppm on day 14 and 7.3 ppm on day 28. The pH dropped from 4.25 to 3.54, respectively, presumably due to organic acid production over time. These findings reveal that PSMs isolated from ERP can serve as effective bioleaching agents for REE recovery, minimizing environmental impact and supporting sustainable resource management.

Keywords: Bioleaching; Eppawala Rock Phosphate; Microorganisms; Rare Earth Elements; Sustainable Green Technology

ICSBE25_187

FABRICATION OF A BIODEGRADABLE FERTILIZER POT AS AN ECO-FRIENDLY ALTERNATIVE TO CONVENTIONAL POLYTHENE BAG POTS

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Abstract: Polythene bags are widely used for planting nurseries. However, due to their non-biodegradability, they cause pollution and damage to ecosystems, which is a serious environmental problem. As an environmentally friendly substitute for traditional polythene bags, a biodegradable pot including fertilizer was introduced. It is fabricated using natural and biodegradable materials. This product is comprised of two parts: the pot and the fertilizer. The pot consists of coir, wheat flour, rubber milk, water, and vinegar. Using these, it was possible to avoid cracking and fungal growth successfully. The testing process involved multiple compositions to determine the optimal composition. The fertilizer consists of stem fiber from banana trees and cow manure, eggshell powder, gliricidia leaf powder, banana peel powder, and wood ash. This biodegradable fertilizer pot consists of three layers. The outermost layer of the pot is prepared using the same material as the pot itself. The middle layer consists of processed areca leaves to prevent water from seeping out. The innermost layer is the fertilizer layer, which serves as a source of nutrients for plants. Further, this layer contributes to the decomposition process of the pot at its end stage due to the availability of microbes. A specific shape for the fertilizer layer was used, in such a way that it protrudes in three places. The purpose is to provide close interaction between plant roots and the fertilizer layer of any plant, especially small plants. The product is cost-effective and environmentally friendly, preventing pollution, and uses waste as a material.

Keywords: Biodegradable; Coir; Fertilizer Pot; Natural Materials and Pollution

ICSBE25_200

DEVELOPMENT OF A SUSTAINABLE BAMBOO - ACTIVATED CARBON COMPOSITE AS A LEATHER SUBSTITUTE FOR IMPROVED FOOTWEAR COMFORT AND HYGIENE

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Abstract: Comfort and hygiene are critical considerations in modern footwear, particularly in hot and humid climates where sweat accumulation and odour are common concerns. This study explores the development of a sustainable, leather-substitute interior shoe material composed of bamboo fibre and activated carbon, integrated into Polyvinyl Alcohol (PVA)-based matrix with natural plasticisers such as Polyethylene Glycol (PEG) and glycerol. The objective was to synthesise a material that effectively controls moisture and odour while having antimicrobial properties. Multiple formulations were tested by varying the ratios of raw material and the optimal ratio was determined based on the physical and biological properties. Bamboo fibre to activated charcoal ratio of 8:3with PVA to PEG ratio of 12:4 was identified as the optimal mix for the leather substitute. This formulation displayed superior performance across various tests, including moisture absorbance of 3.14% (according to ASTM D570), breathability of 0.017 g/cm^2 (accordingly to ASTM E96), odour intensity of 49 ppm/g/cm^2 (according to ASTM D412) and tensile strength of 1.32 MPa (according to ASTM D412).To determine antimicrobial activity, experiments were performed using *Staphylococcus sp.* and *Aspergillus niger* in nutrient agar and potato dextrose agar, respectively. After 24 hrs of incubation, an average inhibition zone of 3.5 mm was observed around the samples on agar plates, confirming effective resistance to microbial growth. This study demonstrates a promising, sustainable, and effective pathway that enhances user comfort and hygiene in footwear applications, using natural and eco-friendly alternative material for leather materials.

Keywords: Activated Carbon; Alternative Leather; Antimicrobial; Bamboo Fiber; Footwear; Moisture Control; Odor Reduction; Sustainable Materials

ICSBE25_216

DEVELOPMENT OF BIODEGRADABLE FOOD CONTAINERS FROM KING COCONUT HUSK AS A SUSTAINABLE ALTERNATIVE TO PLASTIC PACKAGING

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Abstract: The global packaging industry faces growing pressure to replace conventional plastics with sustainable alternatives due to strict regulations and rising consumer demand. In Sri Lanka, King Coconut Husk (KCH) waste, rich in cellulose largely and largely unutilized waste-product, provides a potential raw material for such applications. KCH waste currently lacks primary commercial applications and is often discarded into the environment. This study explores the development of a biodegradable container using KCH fibers, addressing both plastic pollution and agro-waste valorization. Cellulose was extracted from KCH using 35% NaOH at 90 °C for 2 hours (solid-to-liquid ratio 1:10), yielding 18.25% fiber content. FT-IR spectroscopy confirmed effective removal of hemicellulose and lignin. The extracted Fibers (10 -18 g) were blended with kaolin (0.25 - 3 g) as a surface-enhancing filler and polyvinyl alcohol (PVA, 1 -2 g) as a binder. A formulation ratio of 14:1:1.2(cellulose: kaolin: PVA) yielded the optimal surface and mechanical properties. Containers were molded using a heat press at 200 Pa. The biopolymer exhibited a tensile strength of 4.46 MPa and 5.78 % elongation. Soil burial tests showed 29.52%, 38.24% and 39.70% degradation after 7, 14 and 21 days, respectively, confirming environmental compatibility. The study demonstrates the feasibility of producing economical, biodegradable food containers from king coconut husk fibres wastes, thereby offering a sustainable solution for reducing plastic waste and its associated environmental and health impacts.

Keywords: Biodegradable Plastics; Bio-fibre; Food Containers; King Coconut Husk; Urban Waste Valorisation

ICSBE25_218

DEVELOPMENT OF SUSTAINABLE SAWDUST-BASED ACOUSTIC ABSORBER COATING FOR INDOOR NOISE REDUCTION

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Abstract: Rapid urbanization and increasing population density have amplified indoor noise pollution, creating a need for sustainable acoustic control solutions. This study presents the development of an eco-friendly acoustic absorber coating using sawdust, a renewable wood by-product of wood processing. Saw dusts were cleaned, boiled, ground, sieved, and heat-treated at 150 -200 °C under an inert gas environment to enhance porosity and thermal stability. The treated sawdust was then mixed with an eco-friendly Naturelac filler in varying ratios by weight (1:10 to 1:4.5) to create composite coatings and applied on flat panels. Specimens were tested for moisture content, chemical composition, and thermal stability. Thermogravimetric Analysis (TGA) showed enhanced thermal stability after pretreatment, with characteristic weight-loss stages at (temp) with (W%) loss for moisture release and organic decomposition. Acoustic performances were evaluated using a modified impedance tube according to ISO 10534-2, ASTM E1050-12, over a frequency range of 500 Hz to 2000 Hz. The coating with 1.4 mm sawdust particles mixed in a 1:5.5 ratio showed the highest absorption coefficient (α) of approximately 0.510 in the frequency bands from 500 Hz to 2000 Hz. The Coatings with 0.5 mm sawdust particles mixed in ratios of 1:7.5 and 1:5.5 also demonstrated relatively high absorption coefficient values slightly lower than 0.35. The results indicated that the sawdust-based coating can offer performance comparable to conventional synthetic absorbents while significantly reducing the environmental impact. The formulation provides a safe, biodegradable, and low-cost alternative by upcycling sawdust waste into functional acoustic materials.

Keywords: Acoustic Absorbing Coatings; Eco-friendly Coatings; Noise Pollution Control; Sawdust Composite; Sustainable Materials; Upcycling Waste

ICSBE25_244

DEVELOPMENT OF A SUSTAINABLE CONCRETE MIX USING CORAL AGGREGATES AND WASTE RICE HUSK ASH

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Abstract: Wider demand to reduce the environmental impact of construction materials, especially in environmentally sensitive and resource-poor coastal areas, has driven the movement toward sustainable concrete alternatives. This study develops a sustainable concrete mix using coral aggregates as a replacement for normal coarse aggregates and waste Rice Husk Ash (RHA) as a cement partial substitute. The objective is to create an environmentally sustainable yet functional concrete for applications in coastal infrastructure where conventional materials are unavailable or prohibitive. Sri Lankan coral aggregates were well investigated for properties like porosity (54.87%), water absorption (13.14%), Los Angeles abrasion value (43%), and aggregate crushing value (55%). The findings indicate average durability, and the aggregates can be utilized in non-structure and part marine use. RHA from various combusted rice husks was investigated using Fourier Transform Infrared Spectroscopy (FTIR) to evaluate its pozzolanic activity as well as its potentiality as a cement replacement. Based on literature and preliminary trials, 30 MPa compressive strength concrete mix designs were prepared at various RHA replacement levels. Fresh and hardened properties such as slump, density, and 28-day compressive strength were examined. 29.7 MPa strength at 28 days with a slump of 120 mm was achieved in a trial, justifying the fact that a good mix design will have strength and workability. The chemistry of coral aggregates shows a high content of calcium carbonate ($CaCO_3$), testifying to their marine-biogenic nature. Microstructural study reveals that coral aggregates possess an irregular, porous surface, which may enhance mechanical bond but also contribute to enhanced water absorption. Due to their high porosity and salt content, their applications in concrete would need to be limited to non-structural or low-load applications unless they are adequately treated. Pre-treatment methods such as saturation, desalination, and mix design adjustment are recommended to minimize strength and durability problems. Further research is encouraged to assess long-term performance, environmental impacts, and to develop standardized guidelines for their use in sustainable construction.

Keywords: Chemical Characterization; Coral Aggregate Concrete; Coral Aggregates; Mechanical Properties; Rice Husk Ash

ICSBE25_245

SYNTHESIS AND CHARACTERIZATION OF LIMESTONE CALCINED CLAY CEMENT (LC3) USING LOCALLY AVAILABLE CLAY SOURCES

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Abstract: The synthesis of Limestone calcined clay cement (LC3) using locally available natural and industrial clayey materials offers a promising solution to the environmental and economic challenges faced by the cement industry. This study explores the potential of producing such cement by utilizing easily accessible clay sources. A thorough characterization of selected raw materials was conducted to evaluate their chemical, mineralogical, and thermal properties using advanced analytical techniques, including X-Ray Diffraction (XRD), Energy-dispersive X-ray Spectroscopy (EDX), Fourier-transform Infrared Spectroscopy (FTIR), and Thermogravimetric Analysis (TGA). The pozzolanic reactivity of these materials was assessed through the Modified Chapelle Test, and the results confirmed their high reactivity and suitability as supplementary cementitious materials. Experimental trials were carried out to determine the optimum calcination parameters necessary to convert kaolinite-rich clays into reactive metakaolin. The synthesized material was then incorporated into a binder system and tested for its physical and mechanical properties. The results demonstrated favorable performance characteristics, highlighting its potential as a sustainable, low-carbon alternative to traditional Portland cement. This research supports the development of environmentally friendly cement formulations based on locally sourced, cost-effective materials with 40% reduction of CO_2 emission compared to OPC.

Keywords: Cement; Construction; Kaolin; Metakaolin; Pozzolanic Material

ICSBE25_256

FABRICATION AND CHARACTERIZATION OF CuI/SWCNT COATED Au-IDE GAS SENSOR FOR FORMALDEHYDE DETECTION

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Abstract: Formaldehyde is a harmful volatile organic compound that poses serious health risks, including respiratory problems, skin irritation, and potential carcinogenic effects with prolonged exposure. It becomes hazardous at concentrations of 0.5-2 ppm and is widely used in the furniture export industry due to its role in adhesives and resins for wood products. Notably, formaldehyde exposure at just 20 ml through ingestion is fatal, and its permissible limit in exported wooden furniture is strictly regulated at 0.124 ppm. This study focuses on the fabrication and characterization of a formaldehyde gas sensor based on CuI thin film enhanced with Single-Walled Carbon Nanotubes (SWNTs) on an Au interdigitated electrode (Au-IDE). The CuI layer was deposited using a chemical immersion method, preceded by the deposition of a thin gold (Au) film to improve electrical conductivity and current flow across the Interdigitated Electrode (IDE) structure. A SWCNT composite was prepared using polytetrafluoroethylene (PTFE) as both a conductive polymer binder, achieved through spin coating on top of the CuI layer to further enhance sensing performance. Formaldehyde solutions ranging from 0.002 to 0.050 M were used, prepared in 0.002 M increments for low concentrations and 0.010 M increments for higher concentrations. Electrical characterization was performed via linear sweep voltammetry (I-V) measurements in the range of 0 to 1.5 V, with a scan rate of 0.2 V/s and voltage steps of 0.01 V. Additionally, the sensor's dynamic performance was evaluated using chronoamperometry over a 250 s time interval, which revealed an average response time and recovery time are 20 s and 30 s, indicating rapid response behaviour. The results demonstrate that the sensor exhibits good sensitivity and fast response, highlighting its potential for formaldehyde monitoring in both industrial and environmental safety applications.

Keywords: Formaldehyde; IDE Sensor; Recovery Time; Sensitivity; Thin-film

ICSBE25_288

REVIEWING UTILIZATION OF SOLAR ENERGY: EFFICIENCY AND CHALLENGES IN THE SRI LANKAN CONTEXT

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Abstract: The rapid growth of population and technological advancement have intensified global energy consumption continuously. Since burning fossil fuels has led to many environmental challenges, the transition towards renewable energy has become a significant solution today. Among the various renewable energy sources, solar energy plays a key role due to its abundance in tropical climate countries like Sri Lanka. This review examines the current state of solar energy utilization in Sri Lanka, focusing on its efficiency and the challenges faced in its implementation. The review article screening process was conducted by considering peer-reviewed research articles related to solar energy published from 2015-2024, highlighting keywords such as "solar energy," "adoption barriers," "energy efficiency," and "Sri Lankan solar energy projects" using the "Google Scholar" academic search engine. Current daily net electricity generation from small solar power producers, including telemetered values of 10 MW solar parks, estimated values of bulk solar plants (1–10 MW), and rooftop solar plants, is 3.27 GWh, contributing 7.9% to the total electricity production in Sri Lanka. However, several challenges exist with the increasing adoption of solar energy. The main barriers are high initial investment costs, limited access to affordable storage solutions, and intermittent solar irradiance due to seasonal variations. Furthermore, grid integration challenges, regulatory complexities, and insufficient incentives for private-sector involvement are other obstacles to the expansion of solar energy applications in Sri Lanka. From the socio-economic perspective, a lack of public awareness and a shortage of technical expertise in installation and maintenance hinder the full utilization of solar technologies. Opportunities for addressing these challenges, such as policy reforms to streamline regulations, financial incentives to encourage investments, the development of localized storage solutions, and starting public awareness campaigns, should be introduced. By addressing these barriers, Sri Lanka will be able to utilize its abundant solar resources effectively, contributing substantially to its renewable energy targets in the future.

Keywords: Adoption Barriers; Energy Efficiency; Grid Integration; Renewable Energy; Solar Energy; Sri Lankan Solar Energy Projects

ICSBE25_305

DEVELOPMENT OF FOLDABLE PARTITION WALLS USING RECYCLED SLIPPERS' RUBBER

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Abstract: This study investigates the development of foldable partition walls made from recycled slipper waste rubber, addressing the need for low-cost, sustainable, and flexible space management solutions in educational and residential contexts. Five rubber compound formulations were prepared and tested for tensile strength, elongation, and modulus. Sample 5 demonstrated the best balance of strength, stiffness, and flexibility. A prototype wall panel was designed with an aluminium frame and tested for acoustic and thermal performance. Results showed noise reduction between 8.26 dB and 15.13 dB, with satisfactory thermal insulation properties. Cost analysis revealed the recycled rubber partition system to be 44–50% cheaper than conventional aluminium partitions, with added benefits of impact resistance and environmental sustainability. This research confirms the feasibility of upcycling waste rubber into functional building components, promoting circular economy principles and providing affordable solutions for temporary or modular partitions.

Keywords: Acoustic Insulation; Foldable Partition Wall; Recycled Rubber; Sustainable Construction; Waste Rubber

ICSBE25_333

SUSTAINABLE MATERIALS FOR PERSISTENT COOLING PERFORMANCE: ANALYSING THE THERMO-PHYSICAL EFFICACY OF ORGANIC SOLID-SOLID NEOPENTYLGLYCOL PHASE CHANGE MATERIAL

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Abstract: Despite the several hindrances to embrace and address the 17 Sustainable Development Goals (SDGs) of the United Nations, modest-cum-passionate initiatives are gaining momentum from all spheres. Inefficient heat dissemination is one of the major hurdles to achieving SDG 12's target of reducing environmental degradation. The use of sophisticated short-lived electronic devices has increased exponentially over the years. To remain precise, in addition to the silently planned obsolescence at the manufacturer level, the excessive heat accumulation has also worsened the lifespan of electronic components. This work discusses the latent heat storage capability and thermal cycling stoutness of organic solid-solid Phase Changing Material (PCM) for efficient temperature management in electronic assemblies. The PCMs being denser to store thermal energy than other sensible heat storage materials, they can be used as a passive thermal storage for efficient cooling. The experimental study on the effect of utilizing solid-solid phase change of Neopentylglycol (NPG) in electronic cooling applications is explored. Pure NPG is subjected to 250 and 500 thermal cycles. The latent heat and thermal and chemical stoutness of NPG samples were tested by various characterization techniques: DSC, TGA and FTIR. Though thermal cycling did not alter the thermal and chemical firmness of NPG PCM significantly, the tailor-designed heat sink (NPG integrated) had immensely helped to lessen the temperature by 5.8 °C, a step closer to enhance the product lifespan. Therefore, the integration of NPG-based passive cooling in commonly used devices is a viable and effective strategy, indeed a modest sustainable initiative to uphold the very essence of SDG7 and SDG12.

Keywords: NPG; PCM; SDG; Stability; Temperature; Thermocycle

ICSBE25_338

SUSTAINABLE MATERIAL INNOVATIONS FROM ABUNDANT SEA SHORE COCONUT FIBRE

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Abstract: Coconut coir, a natural fiber extracted from the husk of the coconut, is a sustainable and abundant resource that could be better capitalized on. Coir fibers from coastal regions, which are salt-tolerant by nature, are available in abundance but are ignored due to their lower tensile strength in comparison to coir fibers that are cultivated in non-coastal areas. In this research, such coir strings have been studied in detail for their physical and mechanical properties, and an attempt has been made to add value and introduce innovations to such products in order to transform them into high-performance products. Eco Swan, an oil spill cleanup system, utilizes coir fibers to their full potential. The lignin in coir fibers has a rich porous architecture, which enables them to selectively adsorb oil and repel water, therefore serving as a reusable and eco-friendly alternative to synthetic polypropylene pads and reducing the impact of microplastics in water bodies. The coconut safety helmet imitates the coconut's outer protective shell, using lightweight coir composites that provide excellent shock absorption and thermal insulation. The coconut safety helmet draws inspiration from the outer coconut shell by adopting shock absorption and thermal insulation using lightweight coir composites. Although coastal coir is known to have a weaker tensile strength, the helmet achieves breathability, comfort, and sustainable compliance with the BS EN 397:2012 + A1:2012 certification standards through engineered material optimization. The use of salt-tolerant, weak tensile coir from coastal regions to inland low-tensile coir regions, which was previously low in value, is innovatively transformed into a high-value product. This approach enriches industrial value while helping build low-carbon futures by integrating biomimicry, cultural knowledge, and sustainable engineering in a low-carbon engineering approach.

Keywords: Coastal Coir Fiber; Oil Spill Cleanup; Safety Helmet; Salt Tolerance; Value Addition

ICSBE25_340

SUSTAINABLE NATURAL RUBBER FOAMS WITH MODIFIED DIATOMACEOUS EARTH FOR SELECTIVE OIL REMOVAL

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Abstract: Oil spills from marine transportation activities present a major environmental challenge, causing long-term damage to aquatic ecosystems and demanding effective clean-up solutions. Conventional oil sorbents often face limitations such as poor durability, low sustainability, and inadequate selectivity of oil over water, which restrict their large-scale applicability. To address these issues, Natural Rubber (NR) latex foams were developed by incorporating 10 phr of surface-modified Diatomaceous Earth (DE) possessing superhydrophobic properties to enhance oil sorption performance. The water and oil absorption behaviours of the modified DE foams were systematically compared with reference foams which do not contain modified DE of equal density using both visual observations and statistical analyses. Results revealed that the incorporation of DE significantly reduced water uptake and increased oil absorption capacity relative to the reference samples. Selective absorption experiments were further performed using foam cubes (1.5 × 1.5 × 1.5 inches) immersed in a biphasic oil–water system. The DE-incorporated foams displayed a strong preference for oil, with an oil-to-water absorption ratio of 3.2:1, demonstrating effective selectivity, while the reference foams showed no such advantage, recording only a 1:1 ratio. These outcomes emphasize the ability of modified DE to impart enhanced hydrophobicity and oleophilicity to NR foams, thereby producing an eco-friendly, durable, and scalable sorbent material. The study highlights the potential application of these high-performance foams in large-scale marine oil spill remediation, offering a sustainable alternative to conventional sorbents and contributing to environmental protection efforts.

Keywords: Diatomaceous Earth; Natural Rubber Latex Foam; Oil Sorbent; Oil Spill Clean Up

ICSBE25_357

ANALYSIS OF THE PROPERTIES OF OFFSHORE SAND AS AN ALTERNATIVE FOR RIVER SAND IN CONSTRUCTION

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Abstract: This paper discusses the quality and applicability of offshore sand at Muthurajawela stockpile to be utilized in the construction sector with special consideration to the distribution of particles, fine content, shell content, chloride content and acid-soluble sulphate content, as well as total sulphur. The analysis of sieves showed a well-sorted sand profile which is predominantly composed of small to medium-sized particles, which would guarantee high packing density, lower voids and improved the workability of the concrete mixes. The content values of fine contents varied in response to environmental conditions between 0.85-4.34%, however, they remained within acceptable requirements. The shell content was between 1.1-2.3% which is far below the standard of 5%. The chemical tests showed that chloride content could not be higher than 0.00014-0.000425% and thus, it had done away with the significant threat of reinforcement corrosion. Equally, acid-soluble levels of sulphate (0.00022-0.00023%) and total levels of sulphur (0.00009%) were lower than the critical levels outlined in BS EN 1744-1, BS 1377 and SLS 1397 standards. These results affirm a low possible risk of sulphate attack, expansion, or chemical instability. The findings reveal that Muthurarajawela offshore sand is a mechanically sound, chemically stable and sustainably sourced aggregate. It has a stable grading and low impurity, which makes it a good material in the reinforced concrete and general construction, which in turn enhances durability, strength and cost effectiveness. It is suggested that routine observation should help resolve the natural fluctuations, although the stockpile will still be a reliable source for the Sri Lankan construction industry.

Keywords: Chemical and Physical Properties; Concrete; Construction Materials; Offshore Sand; Sustainability

ICSBE25_359

PRODUCTION OF BIOPLASTIC FROM GREEN MICROALGAE (*Chlorella vulgaris*) AS AN ALTERNATIVE TO SINGLE-USE CONVENTIONAL PLASTICS

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Abstract: Globally, the widespread reliance on single-use conventional plastics has resulted in severe environmental challenges due to their non-biodegradability and prolonged persistence. The increasing environmental concerns associated with petroleum-based plastic have intensified the search for sustainable and biodegradable alternatives. Biodegradable bioplastics have emerged as a sustainable, eco-friendly alternative. However, high production costs and limited mechanical performance restrict the commercial scalability of bioplastic products. Green microalgae, particularly *Chlorella vulgaris,* act as a promising feedstock due to their rapid growth, high carbohydrate content, and ability to capture atmospheric CO_2. This study aimed to develop a biodegradable bioplastic in a cost-effective manner using Cellulose Nanocrystals (CNCs) extracted from *C. vulgaris.* Algal culture was scaled up using a low-cost cultivation method and harvested using a selected flocculant. Then, it was subjected to alkaline treatment, followed by bleaching and acid hydrolysis to yield CNC. Extracted CNC was neutralized and purified. Then, the purified yield was processed into a bioplastic film with a novel mixture of ingredients, followed by characterization. According to the findings, 22.11% of the yield resulted from 15.06 g of dried *C. vulgaris* biomass as the main raw material. Fourier-Transform infrared spectroscopy confirms the presence of polymeric linkages, including Amide I and Amide II bands, C–N stretching, and Ether bonds. Bioplastic indicated a resin structure, suggesting potential mechanical stability. The processed bioplastic film further exhibited functional properties such as moderate solubility and controlled moisture absorption. Preliminary cost analysis suggested competitive production potential compared to conventional bioplastics. Overall, results highlight the application of *C. vulgaris* as a promising microalgal source for biodegradable bioplastic production with adequate strength and sustainability. With further optimization in large-scale cultivation and processing, microalgal bioplastics can significantly contribute to reducing plastic pollution with a circular bioeconomy.

Keywords: Bioplastic; Cellulose Nanocrystals; Cost-Effectiveness; Pollution Control; Sustainability

ICSBE25_457

REVITALIZING SKILLED CRAFTSMANSHIP THROUGH SUSTAINABLE MATERIALS AND INNOVATION: A MODEL DESIGN FOR AN ADVANCED POTTERY TRAINING CENTER IN MIRIGAMA

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Abstract: Sri Lanka, with its rich cultural heritage, has long been renowned for its vibrant handicraft traditions. Among these crafts, pottery stands out as one of the oldest, sustained by abundant raw materials and evolving from functional wares to innovative decorative forms. In Mirigama, pottery is a cherished generational craft, practiced in villages such as 28-E-Webadamulla, 14-Bothale Pahalagama, and Nalla, where families have passed down their skills through generations. Despite Mirigama's rich pottery heritage and strategic location, the sector is declining due to limited support, outdated production facilitation, low youth engagement, and restricted market access, highlighting the need for revitalization through sustainable development for innovation. The study aims to find an avenue to revitalize traditional pottery in Mirigama through structuring a model design that provides modern infrastructure and nurtures youth skills. It incorporates innovation and sustainable practices and promotes value-added product creation through artisan mentorship and knowledge transfer. While employing a qualitative research method, combining primary and secondary data, the research offers a comprehensive understanding of pottery craftsmanship in Mirigama and the challenges faced by artisans. Primary data was collected through deep on-site observations and surveys, interviews with pottery craftsmen, and stakeholder consultations. Secondary data was obtained from statutory reports, surveys and recorded sources of investigations. The model design addresses space planning, functional distribution, spatial volume, energy requirements, and regulatory considerations, while integrating the phases of pottery manufacturing, storage, clay preparation, shaping and moulding, drying, firing, and finishing, to ensure both cultural continuity and contemporary relevance. By combining sustainable production strategies with innovation, it enhances the economic and cultural value of Sri Lankan pottery while empowering local craftsmen. The initiative is expected to attract tourism, promote sustainable value-added products, and establish Mirigama's cultural identity, ultimately generating sustainable livelihoods and fostering a self-sustained pottery community that advances social, environmental, and economic sustainability.

Keywords: Mirigama; Model Design; Pottery Craftsmanship; Sustainable Materials; Training Center

ICSBE25_499

EFFECT OF FIBER LENGTH ON THE MECHANICAL AND PHYSICAL PROPERTIES OF BAUHINIA RACEMOSA-REINFORCED POLYESTER COMPOSITES

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Abstract: Natural fiber reinforced composites have been recognized as potentially sustainable alternatives to synthetic composites. The present work has evaluated the fiber length dependency of a high-strength natural abundance local fiber, *Bauhinia Racemosa* (Bidi leaf tree fiber), which was used to produce polyester-based composites and examine how various fiber lengths impacted mechanical, thermal, and physical characteristics of the composites. These composites were produced using polyester resin and reinforced fiber at different lengths (10, 20, 30, 40, 50, and 60 mm). Tensile strength, impact resistance, flexural strength (MOR), thermal conductivity, water absorption, density measurement, Brinell hardness, and wear resistance of the samples were evaluated. As fiber length increased to 60 mm, mechanical test values increased in tensile strength (9.98 MPa), flexural strength (131.50 MPa), and impact strength (140 J), as the effectiveness of stress transfer and interfacial bonding improved with longer fibers. Minor increases in water absorption and wear percentage were noted in the 60 mm composites. Thermal conductivity was also increased with fiber length. SEM and optical microscope imagery confirmed uniform fiber dispersion and strong adhesion in samples with varying fiber lengths. This study emphasizes the importance of fiber length in bio-composite development using Bidi fiber rather than environmentally taxing non-biodegradable synthetic fibers.

Keywords: *Bauhinia Racemosa*; Fiber Length; Mechanical Properties; Natural Fiber Composites

ICSBE25_557

CLAY POTTERY INDUSTRY IN SRI LANKA: TOWARDS MOST USABLE CLAY TYPE FOR COOKING CLAY POTTERY, GENDER INVOLVEMENT, INDUSTRY TYPE INVOLVEMENT AND PRODUCT VARIATION

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Abstract: Clay pottery, originating at the dawn of civilization, is a fundamental village industry primarily used as eco-friendly and health-safe cookware. Thus, this study is focused to investigate the current status of the clay pottery industry in Sri Lanka, focusing on the most usable clay type for cooking clay pottery, gender involvement, industry type involvement and product variation relevant to the clay industry in Sri Lanka. The relevant data were collected through the primary and secondary data accumulation methods from an industrial survey and literature review. The literature review indicates that Red, Ball, and White clay types are the most widely utilized raw materials in Sri Lanka's clay industry. According to the industrial survey findings, Red clay is the most usable material for cooking pottery, predominantly utilized by small-scale domestic manufacturers. There are three main categories of pottery production industry types, which are medium-scale industries, small-scale domestic manufacturing units, and government-sponsored clay villages and training centers. Among these, small-scale domestic centers represent the majority and exhibit the highest utilization of Red clay. Gender participation analysis reveals that male involvement is predominant across all industry types, although both male and female participation are most common in small-scale domestic pottery production. In addition to cooking pots, other clayware products are manufactured, including seasonal items such as milk pots, whereas cooking clay pottery is produced year-round. Nevertheless, the absence of large-scale production centers highlights the potential for industry expansion through technological advancement. Gender participation remains uneven, with female involvement being minimal. Enhancing both male and female participation, particularly in the industry, can strengthen the sector, with government-led awareness programs serving as a mechanism for improvement. However, currently, the clay pottery industry exhibits significant potential for advancement through the adoption of modern processing technologies, material optimization, and value-added applications that enhance functional performance and market competitiveness.

Keywords: Clay Cookware; Clay Pottery Industry; Gender Participation; Industry Types; Red Clay

ICSBE25_652

ISOLATION AND CHARACTERIZATION OF POLYSACCHARIDES FROM TAMARIND AND RELATED SEEDS FOR USE IN ELECTROSPUN NANOFIBERS AS A DRUG-DELIVERY AGENT

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Abstract: Xyloglucan (XG), primarily extracted from tamarind seeds and other higher plants, is an emerging natural hemicellulose-based polysaccharide that has recently gained attention in targeted and sustained drug delivery systems. This interest stems from its desirable properties, such as mucoadhesivity and in-situ gelation, although its poor mechanical strength and limited structural stability prevent it from being used alone in advanced formulations. To address these limitations, XG was combined with two synthetic polymers, polyvinylpyrrolidone (PVP) and ethyl cellulose (EC), to enhance strength and electrospinnability. This study aimed to isolate and characterize XG from tamarind seeds and other sources, and to fabricate electrospun nanofiber mats blended with XG, PVP, and EC for the sustained release of diclofenac sodium, a common nonsteroidal anti-inflammatory drug with a short half-life. XG was isolated using an ethanol-based extraction method, and the extraction efficiency was calculated for tamarind and ten other seed sources. Structural integrity was confirmed through Fourier-transform Infrared Spectroscopy (FTIR) and X-ray Diffraction (XRD). Nanofibers were produced via electrospinning of XG/PVP/EC aqueous solutions. SEM analysis showed uniform, bead-free fibers with an average diameter of 212 nm, forming a porous network ideal for drug delivery. In vitro drug release studies indicated that diclofenac sodium was gradually and steadily released over six hours, with approximately 11% of the drug released cumulatively. Release kinetics analysis revealed that the data fit well to the Korsmeyer-Peppas model (R^2 = 0.99), with a release exponent of 1.63, indicating super case II transport rather than the zero-order or Higuchi models. In conclusion, this study highlights tamarind-derived XG as a biocompatible and sustainable pharmaceutical excipient, while electrospun nanofibers of the XG/PVP/EC blend serve as effective systems for controlled drug delivery, combining natural polymer applications with eco-friendly and advanced pharmaceutical technologies.

Keywords: Biocompatible Excipient; Diclofenac Sodium; Electrospun Fibers; Higher Plant Seeds; Xyloglucan

ICSBE25_653

HALLOYSITE CLAY INCORPORATED PVP/PCL ELECTROSPUN FIBER MESHES AS HEMOSTATIC WOUND DRESSINGS.

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Abstract: Halloysite Nanotubes (HNTs) are naturally occurring clay minerals characterized by their unique tubular morphology. Due to their high mechanical strength, excellent biocompatibility, intrinsic hemostatic properties, and wound healing potential, HNTs hold significant promise for wound care applications. This study aimed to develop HNT-incorporated electrospun fiber mats composed of poly(ε-caprolactone) (PCL) and polyvinylpyrrolidone (PVP) for potential use as hemostatic wound dressings. Two polymer blend ratios, PCL: PVP at 1:1 and 2:1, were employed to fabricate the fibers. The electrospinning was employed to obtain fiber mats. For the fabrication of HNT-dispersed electrospun fiber meshes, 5% w/w HNTs (based on the total polymer weight) were introduced in both polymer combinations. Optimized electrospinning of HNT-loaded fibers was performed under similar environmental conditions, using voltages ranging from 14.5 kV to 15 kV. The fabricated electrospun mats were characterized using Fourier Transform Infrared Spectroscopy (FT-IR), X-ray Diffraction (XRD), and Scanning Electron Microscopy (SEM), which confirmed the successful integration of HNTs within the polymer matrix. Swelling studies indicated that HNT-loaded PCL: PVP (1:1) fibers exhibited the highest water absorption capacity, attributed to the hydrophilic nature of PVP and the absorptive capacity of HNTs. In contrast, neat PCL fibers displayed the lowest swelling behaviour due to their inherent hydrophobicity. Whole blood clotting assays revealed that the incorporation of HNTs significantly enhanced clotting performance. The HNT (5%) incorporated PCL: PVP (1:1 and 2:1) mats demonstrated excellent clotting time efficiency with 59.18% and 65.17%, respectively, compared to the control. These findings highlight the potential of HNT-incorporated PCL/PVP nanofiber meshes as effective hemostatic wound dressings, particularly for use in acute wounds, burn injuries, and hemorrhagic conditions, such as those encountered during surgical procedures and battlefield trauma.

Keywords: Electrospinning; Halloysite Nanotubes; Hemostasis; Wound Dressings

ARTIFICIAL INTELLIGENCE FOR SUSTAINABLE DEVELOPMENT: CHALLENGES AND OPPORTUNITIES

ICSBE25_135

AI-DRIVEN COGNITIVE ASSESSMENT IN PROGRAMMING EDUCATION: A BLOOM'S TAXONOMY-ALIGNED FRAMEWORK FOR SKILL DEVELOPMENT

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Abstract: Assessing programming skill development remains a persistent challenge in modern education, as traditional evaluation methods often fail to capture students' cognitive progress beyond code correctness, execution efficiency, and completion time. This study explores the integration of Artificial Intelligence (AI) with Bloom's Taxonomy to establish a structured, data-driven, and scalable framework for assessing programming proficiency within educational coding platforms. By leveraging AI-driven analytics and cognitive modelling, the proposed framework enables real-time classification of coding tasks across Bloom's six cognitive levels, facilitating adaptive feedback and personalized learning pathways for students. Unlike prior studies focusing solely on syntactic accuracy or test case validation, this research uniquely incorporates both semantic and structural analysis of student code using transformer-based and graph-based models to quantify learning progression. The system dynamically adjusts task difficulty and learning trajectories according to each learner's cognitive profile, thereby bridging gaps between conceptual understanding, analytical reasoning, and creative problem-solving. Experimental validation through controlled classroom trials demonstrated statistically significant improvements in students' cognitive-level transitions and engagement when compared to traditional assessment methods. The findings confirm that AI-enhanced Bloom's mapping not only automates assessment but also promotes deeper computational thinking, curriculum alignment, and data-informed pedagogical decisions. This study highlights the transformative potential of explainable AI in redefining programming education and cognitive skill development in the digital learning era.

Keywords: Artificial Intelligence in Education; Bloom's Taxonomy; Cognitive Development; Cognitive-level Assessment; Machine Learning; Programming Skill Evaluation

ICSBE25_155

ETHICAL AI DEPLOYMENT IN SUSTAINABLE HEALTHCARE FACILITIES: LESSONS FROM DIABETES PREDICTION

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Abstract: Sustained high incidence of Type 2 Diabetes Mellitus (T2DM) is a serious non-communicable disease constituting a major public health issue, especially in poor resources such as in Sri Lanka. "Guardian AI," a machine learning model employing artificial intelligence to predict T2DM risk based on the clinical histories of Kuliyapitiya hospital, North Western province of Sri Lanka, is proposed in this study. The aim of the study is to develop an interpretable, scalable, and accurate machine learning model that would feasibly facilitate early detection and intervention and thereby relieve the disease burden of local health care systems. With a quantitative, deductive study design, the study employs supervised machine learning algorithms, Random Forest, Support Vector Machine (SVM), and Logistic Regression, which were developed based on a clinical parameters dataset such as age, Body Mass Index (BMI), blood pressure, glucose, and cholesterol. Primary data were obtained ethically from anonymized patient records. The Random Forest model performed the best with 99% accuracy, 100% recall, and 0.9 AUC, indicating better performance to predict persons at risk. Statistical validation via SPSS through Pearson correlation, t-tests, and logistic regression validated the predictors' significance. Ethical issues in the study were resolved since data confidentiality and respect for the Belmont Report principles were ensured. Despite being effective, the limitations are missing longitudinal data and the use of a single geographic dataset, which restricts generalizability. Recommendations for the future include using real-time data, expanding datasets to increase diversity, and seeking federated learning in order to improve privacy and scalability. With the intersection of clinical usefulness and computational precision, Guardian AI offers a low-cost, patient-centric diabetes prediction platform, with additional potential applications in other non-communicable diseases, thus enhancing Sri Lanka's preventive health agenda as well as global health technology.

Keyword: Artificial Intelligence; Clinical Data; Diabetes; Machine Learning

ICSBE25_156

LEVERAGING AI FOR SUSTAINABLE APPAREL EXPORT FORECASTING: A DATA-DRIVEN APPROACH TO STRENGTHEN INDUSTRY INNOVATION AND RESPONSIBLE PRODUCTION IN SRI LANKA

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Abstract: The apparel industry of Sri Lanka has been one of the country's main exports, bringing in more than 40 percent of the overall exports of the country, but it is extremely susceptible to economic shocks across the globe, post-pandemic fluctuations, and any sudden alteration in tax and trade policy. These are complex and non-linear, disruptive, but are not described well by traditional forecasting models that tend to lend out many important policy-driven factors. To surmount this, the current paper proposes an AI-enhanced forecasting model that includes a new macro-policy determinant, the so-called Export Tax pressure, that would capture the effects of real-world changes in trade policy like tariff increases, GSP+ status changes, VAT regulation changes, and the like on apparel exports. Most importantly, the work uses a Large Language Model (LLM) to interpret the unstructured text policy (e.g., news headlines, regulatory updates) and transform it into numerical impact indicators in structured form. These are subsequently combined together with macroeconomic series in a time series to be modeled. Considering the data spanning the interval of 2000 - 2023, the study compares four supervised machine learning algorithms, i.e., Linear Regression, Decision Tree, Random Forest, and Extreme Gradient Boosting (XGBoost). Of them, the highest forecasting accuracy ($R^2 = 0.989$) was provided by XGBoost, and the lowest values of MAE and RMSE. The feature importance analysis continued to validate the model as Export Tax Pressure was ranked as the second most significant factor, second only to the exchange rate, in terms of influencing the determinant. The research proposes a technically solid and scalable tool by reconciling qualitative policy stories with quantitative predictions by using LLM preprocessing and AI modeling. It empowers policymakers and manufacturers to have real-time data-based decisions in an uncertain global trading scenario. This is an export forecasting leap to a new generation in which the policy intelligence is combined with machine learning to aid the national economic strategy and national competitiveness.

Keywords: GSP+; LLM; Machine Learning; Tariffs; VAT Reforms; XGBoost

ICSBE25_158

SPATIOTEMPORAL ANOMALY DETECTION FOR ENVIRONMENTAL HAZARDS IN SRI LANKA USING CNN-LSTM AUTOENCODERS

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Abstract: Environmental hazards such as floods, cyclones, and landslides pose significant threats to lives and livelihoods in Sri Lanka, under worsening climate conditions. Traditional forecasting methods face challenges due to limited labelled data, high spatiotemporal variability, and the lack of integrated satellite observations. This study introduces an unsupervised spatiotemporal anomaly detection framework based on a Convolutional Long Short-Term Memory (CNN-LSTM) Autoencoder to identify environmental anomalies associated with disaster events. The Spaciotemporal hybrid AI (Artificial Intelligence) model is trained exclusively on non-disaster sequences, combining daily weather data with satellite-derived brightness features, using an 8-day temporal sliding window. It demonstrated moderate performance, achieving an F1-score of 0.41, with detected anomaly clusters spatially aligned with known high-risk regions. Unlike supervised AI models, this approach detects hazards without the need for labelled data, offering practical advantages for early warning in data-scarce environments. The study also highlights key limitations in existing public disaster datasets, such as insufficient spatial resolution and a lack of real-time ground-truth data. Future work will focus on acquiring higher-resolution and real-time data sources, integrating attention mechanisms for better spatiotemporal modelling, as well as exploring multi-model late fusion strategies, and aligning the system with national early warning infrastructures to enhance disaster resilience and adaptive response.

Keywords: Climate Resilience; CNN-LSTM Autoencoder; Environmental Hazards; Satellite–weather Fusion; Spatiotemporal Anomaly Detection; Unsupervised Learning

ICSBE25_174

SPATIOTEMPORAL SPREAD PATTERN FORECASTING OF DENGUE IN KANDY DISTRICT: A REVIEW

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Abstract: Accurate forecasting of dengue outbreaks is critical for reducing disease burden and guiding timely public health interventions. In Sri Lanka, dengue has become an island-wide, year-round concern, with more than 36,000 cases reported by May 2023, nearly three times higher than during the same period in the previous two years. Recurrent outbreaks in the Kandy District highlight the need for reliable, locally adaptable prediction systems. Traditional regression and time series models have been widely applied to explore climatic drivers such as rainfall, temperature, and humidity. However, their linear assumptions often fail to capture the complex, nonlinear interactions that shape dengue transmission. In response, recent research has increasingly explored machine learning and geospatial approaches as alternatives to traditional models. These methods aim to capture complex, nonlinear, and spatially dependent dynamics of dengue transmission that conventional techniques often overlook. Nonetheless, many current predictive systems remain constrained by inconsistent data quality, underreporting, and limited spatial resolution. This review aims to synthesize recent research on spatiotemporal and machine learning based models for dengue forecasting, with an emphasis on their applicability to the Kandy district. It summarizes methodological trends, key findings, and persistent challenges, underscoring the need for region-specific, data-integrated modelling frameworks to support early warning and targeted dengue control in high-risk areas.

Keywords: Dengue Prediction; GIS; Kandy District; Machine Learning; Spatiotemporal Modelling

ICSBE25_205

OPTIMIZING CHEMICAL USAGE FOR SUSTAINABLE SHRIMP FARMING THROUGH AI-DRIVEN INNOVATION: A CASE STUDY ADVANCING ENVIRONMENTAL RESILIENCE AND SMART ACQUACULTURE SYSTEMS

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Abstract: Bacterial diseases like vibriosis and Early Mortality Syndrome (EMS) are becoming more of a challenge to shrimp aquaculture in Sri Lanka, which means more chemical is used, environmental degradation occurs, and costs of operations increase. To address this, the study provides an AI-powered, information-based approach to maximizing chemical spending and ensuring sustainable and resilient aquaculture models. To guarantee internal consistency and construct validity, a mixed-method design was applied, which combined quantitative surveys, qualitative expert interviews, and a five-year secondary data (2020 - 2024) of KMN Aqua Services (Pvt) Ltd. to validate statistical validation using SPSS through Descriptive Analysis, Normality Testing, Pearson Correlation, Cronbach Alpha Reliability, and the Exploratory Factor Analysis. To do predictive modelling, the supervised machine learning methods such as Random Forest Regression and Long Short-Term Memory (LSTM) were applied. The best model is LSTM, which has superior accuracy ($R^2 = 1.00$, MAE = 8.42, RMSE = 10.70) and can be used as a time-series predictor of chemical expenses. The frequency of the disease, stocking density, water quality, use of diagnostic tools, and market price of chemicals were also indicated as significant cost drivers in the study. Thematic findings of the interview were in line with the statistical data and provided the practical steps, like the introduction of AI (especially LSTM) into the management of the diseases, the extension of the diagnostic applications, the better stocking of the farms, and the improvement of the digital literacy of the farm staff. These contributions contribute to the Sustainable Built Environment through lessening the use of chemicals, preserving the water ecosystems, and contributing to the aquaculture ecologically. Moreover, the incorporation of LSTM is an example of next-generation innovation that introduces intelligent forecasting into the conventional practice. In general, the study presents a scalable model of intelligent aquaculture that balances environmental concern with financial efficiency and paves the way for further uses of AI in rural sustainability and food availability.

Keywords: Artificial Intelligence (AI); Chemical Cost Optimization; Environmental Resilience; Machine Learning (ML); Shrimp Farming; Sustainable Aquaculture

ICSBE25_217

INNOVATION PERFORMANCE IN SRI LANKA COMPARED TO SOUTH ASIAN COUNTRIES: A CRITICAL AI BASED REVIEW OF OPEN AND CLOSED INNOVATION PRACTICES

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Abstract: Sri Lanka ranks 89th in the Global Innovation Index (GII) 2024, reflecting a relatively low position among 133 economies, demonstrating the country's innovation capacity, particularly in R&D investment, institutional coordination, university–industry collaboration and technology diffusion. As such, a need arises for reassessing the country's innovation practices, especially through the lens of open and closed innovation practices. The team of the FOUNTAIN project at the HCBT campus, supported by the EU Erasmus program, conducted an in-depth review of South Asian literature by stressing keywords on open and closed innovation using ChatGPT, Gemini, and Google Scholar domains. The review was conducted in the four stages of the PRISMA framework (identification, screening, eligibility, and inclusion). There were altogether 90 papers published during 2003 - 2025, out of which 10 were excluded. While establishing AI-assisted reviewing was an efficient and useful tool for quick data merging and trend setting, the human verification remains essential in ensuring accuracy and academic integrity. It was evident that the forward-looking industries driven by global collaborations, such as ICT and FinTech, are applying the open innovation model, which are gradually gaining prominence. The traditional sectors like plantation and manufacturing remain inward-looking and resistant to external knowledge flows. Here, the key resistance for open innovation appeared to be a lack of trust in external actors, weak intellectual property regimes, institutional fragmentation, dearth of policies, regulations and conducive environments. As per South Asian literature, especially related to India and Sri Lanka, universities and governments greatly incorporate startup collaboration compared to other countries. Nevertheless, in Sri Lanka, open innovation is only dominant in selected sectors, and it is happening far behind compared to regional counterparts, like India. Strengthening the institutional framework's trust and policy adoption are needed for the SMEs to reduce the gap.

Keywords: Closed Innovation; Entrepreneurship; Innovation Ecosystem; Open Innovation

ICSBE25_324

DESIGN OF A SUSTAINABLE MULTISENSORY ASSISTIVE TOY FOR CHILDREN WITH CORTICAL VISUAL IMPAIRMENT (CVI)

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Abstract: The most common cause of vision loss in children can be called as Cortical Visual Impairment (CVI), resulting from a neurological disease that destroys the brain's capacity for processing visual information. Unlike ocular conditions, CVI necessitates treatments that promote cognitive and perceptual development by addressing both visual and multisensory pathways. Although there are many assistive technologies available, the majority are either pricy, only available in clinical settings, or do not take long-term sustainability into account. The goal of the project is to design a low-cost multisensory training toy that utilizes biomedical engineering to provide a low-cost, safe, and environmentally friendly solution for children with CVI. The suggested device is envisioned to be a cube or ball toy that incorporates tactile, visual, and auditory stimuli to facilitate focus and attention. It uses programmable RGB LEDs, vibration motors, and miniature speakers that are managed by an Arduino/ESP32 microcontroller to create programmable sensory patterns. Each face of the device has a different stimulus, ranging from moving light patterns, sound-activated light, flashing red lights, or vibrotactile stimulation. Low-power electronics, rechargeable batteries, and a 3D-printed enclosure from biodegradable PLA are all design elements that make the device sustainable. Due to its modular design, the device can be repaired and reused, extending its life and minimizing electronic waste. From a therapeutic perspective, the toy facilitates multisensory integration, allowing children to associate touch and auditory stimuli with visual responses. The device overcomes the particular difficulties that children with CVI encounter in clinical and domestic settings by minimizing visual clutter and enabling individualized stimulation. In addition to its therapeutic value, the research demonstrates how biomedical engineers can support sustainable healthcare innovations that integrate affordability, accessibility, and environmental sustainability. Overall, this research advocates inclusive healthcare technologies and supports global environmental objectives.

Keywords: Arduino-Based Device; Assistive Technology; Cortical Visual Impairment (CVI); Multisensory Stimulation; Pediatric Rehabilitation; Sustainable Design

ICSBE25_352

MACHINE LEARNING-BASED PLANT SELECTION FOR ROOF GARDENS IN SRI LANKA: A PROVINCIAL-WISE FRAMEWORK FOR URBAN SUSTAINABILITY

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Abstract: South Asian cities are confronting increasing problems with heat stress, and environmental damage as well as food shortages as a result of the region's increasing urbanization. More and more people are realizing that roof gardens are multipurpose green infrastructure that may reduce the urban heat island effect, increase food self-sufficiency, and strengthen urban resilience. When choosing plant species for rooftop settings, it's important to take into account a variety of agroclimatic, geographical, and socioeconomic considerations. This research suggests a plant recommendation system based on machine learning for choosing plants according to provinces in order to maximize rooftop agriculture in Sri Lanka's metropolitan areas. An extensive plant dataset, including information on prevalent soil types, height, root length, leaf coverage, thermal conductivity, albedo, life span, and agro-climatic factors (temperature, rainfall, and humidity) was created. Nine provinces' worth of supervised machine learning algorithms, including as Linear Regression, Random Forest, K-Nearest Neighbors Regressor, and Support Vector Regression, are used to forecast the best crops for rooftop use. Linear Regression and Support Vector Regression demonstrated the highest predictive accuracy, with R^2 scores of 0.7950 and 0.7951, respectively. From the evaluation results, Linear Regression and Support Vector Regression methods were concluded as the most suitable models for predicting thermal conductivity of plants in the context of optimizing thermal comfort.

Keywords: Energy Saving; Indoor Thermal Comfort; Machine Learning; Optimum Crop; Roof Garden; Sustainable Agriculture

ICSBE25_454

AN AI-GUIDED ASSISTANT FOR MULTI-CRITERIA SUSTAINABILITY DECISIONS

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Abstract: Multi-Criteria Decision Analysis (MCDA) remains inaccessible to non-expert stakeholders due to the technical complexity of traditional tools, limiting effective decision-making in sustainability applications where comprehensive evaluation of environmental, social, and economic trade-offs is essential. The Model Context Protocol (MCP) provides a new generation of AI-driven frameworks that make advanced analytical methods accessible through simple and adaptive interfaces, enabling stakeholders, particularly non-experts, to use methods such as Multi-Criteria Decision Analysis (MCDA) without dealing with the technical complexity of tools like Analytical Hierarchy Process (AHP) or Preference Ranking Organisation Method for Enrichment of Evaluations (PROMETHEE). To address systematic decision-making deficiencies in accessible MCDA implementation, this research develops an AI-guided Sustainability Assistant (ASA) utilizing Model Context Protocol technology integrated with Life Cycle Sustainability Assessment principles through an MCP-enabled, agentic AI server. ASA is designed to translate complex environmental, social, and economic trade-offs into intuitive, transparent rankings that can be directly applied in practice. The solution implements a modular architecture featuring Multi-Criteria Decision Analysis through PROMETHEE and AHP methodologies, enabling comprehensive evaluation of environmental, economic, and social trade-offs in sustainability decision-making. To validate this approach, methodological validation involved utilizing strawberry plantation Life Cycle Assessment data to evaluate agricultural plastics and substitutes through comparative analysis between the ASA system and Visual PROMETHEE software. Results demonstrate that ASA achieves improved decision-making efficiency compared to conventional methods, successfully ranking diverse material alternatives across multiple sustainability criteria while maintaining transparency. Validation confirms that ASA provides more balanced, transparent, and user-friendly guidance than existing MCDA software with enhanced accessibility and reliable sustainability assessments. By coupling MCP's adaptive AI interfaces with rigorous LCA and MCDA, the AI-guided Sustainability Assistant empowers stakeholders, including farmers, policymakers, and manufacturers alike, to make informed and balanced decisions, ultimately advancing sustainable practices through accessibility and trust.

Keywords: AI-driven Decision Support; Life Cycle Assessment; Model Context Protocol; Multi-Criteria Decision Analysis; Sustainability Assistant

ICSBE25_482

DEEP CONVOLUTIONAL NEURAL NETWORKS FOR IMAGE-BASED DETECTION AND CLASSIFICATION OF TOMATO LEAF DISEASES

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Abstract: Timely, accurate diagnosis of plant diseases is critical for precision agricultural practices and sustainable production practices of crops. This research develops a convolutional neural network approach for the classification of tomatoes leaf diseases autonomously. The data set comprised 10,000 images of unaffected and diseased leaf conditions covering nine different disease classes, such as Bacterial Spot, Early Blight, Leaf Mold, Late Blight, Yellow Leaf Curl Virus, Target Spot, Septorial Leaf Spot, Spider Mites, and Mosaic Virus. Each image was pre-processed by resizing, normalizing, and label-encoding. The convolutional neural network was developed to have several convolutional and pooling layers with a ReLU activation function, batch normalization to help stabilize learning, dropout layers to reduce model over-fitting, and a final fully connected layer with a Softmax activation function for the purpose of classification. The convolutional neural network was able to be implemented with the Adam optimizer at a learning rate of 0.0001. The trained convolutional neural network achieved a moderate performance, confirming that the trained model was able to classify each of the nine species with statistical value, attaining an overall accuracy of 61.03%, precision of 62.12%, and recall of 61.03%. Whereas the classifier struggled to distinguish between diseases such as Leaf Mold and Septoria Leaf Spot, as each disease presents with similar visual symptoms. In future work, the model accuracy and reliability can be improved through more advanced pre-processing methods, such as data augmentation, and by conducting tests in actual farming conditions.

Keywords: Convolutional Neural Network; Disease Detection; Image Classification; Precision Agriculture; Tomato

ICSBE25_484

DEEP LEARNING-BASED LEAF IMAGE ANALYSIS FOR ACCURATE CLASSIFICATION OF TOMATO CULTIVARS

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Abstract: Tomato (*Solanum lycopersicum*) stands as one of the world's most significant vegetable crops, valued for its nutritional content and economic impact. In this study, the tomato leaf image dataset consists of eleven verified tomato cultivars. A structured pre-processing pipeline was applied to segment tomato leaves, ensuring clean isolation from the background. Tomato variety classification is challenging due to high similarity in leaf morphology among cultivars. To build a robust and generalizable model, 6 state-of-the-art Convolutional Neural Networks architectures were used: InceptionV3, InceptionResNetV2, EfficientNetB3 and B5, ResNet50, and MobileNetV2. Input images were resized to the recommended dimensions for each model, used custom classification heads. To prevent overfitting, an online augmentation pipeline was used. Evaluate using stratified cross-validation and each sample was used once as a test case and performance metrics, including per-class precision, recall, F1-Scores and confusion matrices, were averaged across folds. Among all models, EfficientNetB5 achieved the highest average accuracy of 90.55% with the lowest standard deviation of 1.6%, indicating high confidence and robustness to biological and sampling variability. The way how tomato varieties are distributed in their respective feature space visualization by using 3D principal component analysis for all models were analyzed to gain deeper insights into the internal representations learned by models. When compared to other models, EfficientNetB5 displayed well-separated clusters with moderate spread, indicating robust distinction between cultivars. Ultimately, the methodology recommended in this research is important for identifying variety-specific features and further improvements can be achieved by adding more varieties and integrating the model into a mobile platform for real-time monitoring.

Keywords: Classification of Cultivars; Convolutional Neural Network; Deep Learning; Principal Component Analysis; Tomato

MARINE BIORESOURCES AND SUSTAINABLE APPLICATIONS

ICSBE25_074

IDENTIFICATION OF SUITABLE CARBON SOURCES FOR THE GROWTH PERFORMANCES OF *Poecilia reticulate* IN THE BIOFLOC SYSTEM

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Abstract: Biofloc Technology (BFT) is an emerging aquaculture practice that enhances nutrient recycling and promotes the formation of microbial flocs by supplementing external carbon sources. This study evaluated the influence of five different carbon supplementation strategies on the growth performance, water quality, and immune response of *Poecilia reticulate* cultured under biofloc conditions. A 45-day experiment was conducted using 1,440 guppy fingerlings (0.10 ± 0.01 g), randomly allocated in 18 fiberglass tanks (80 L), and subjected to treatments with molasses (T1), rice bran (T2), wheat flour (T3), molasses + rice bran (T4), molasses + wheat flour (T5), and a control group without carbon addition (C). All tanks were maintained at a C/N ratio of 15:1 at the initial stage, and a 1:6 C/N ratio was used later. Significant improvements in weight gain ($254.52 \pm 20.03\%$) and specific growth rate ($2.81 \pm 0.07\%$) were observed in T4 compared to the control ($p < 0.05$). T4 also exhibited and highest survival rate ($93.33 \pm 2.08\%$), followed closely by T5 ($91.67 \pm 0.83\%$). Furthermore, water quality analysis revealed reduced total ammonia nitrogen and nitrite levels in T4 and T5, indicating enhanced microbial nitrogen assimilation. Upon challenge with *Aeromonas hydrophila*, fish in T2 and T4 treatments demonstrated superior post-challenge survival rates, suggesting enhanced immune competence. These findings highlight the effectiveness of a combined molasses and rice bran carbon source in improving growth, water quality, and disease resistance in guppy culture. This study provides practical insights for developing sustainable and economically viable biofloc-based aquaculture systems.

Keywords: *Aeromonas hydrophila*; Fish Immunity; Microbial Floc; Sustainable Aquaculture; Zero Water Exchange

ICSBE25_152

MICROPLASTICS IN MARINE ENVIRONMENTS: A REVIEW ON ECOLOGICAL IMPACTS, HUMAN HEALTH CONCERNS, AND SUSTAINABLE SOLUTIONS

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Abstract: Microplastics (MPs) (plastic particles smaller than 5 mm) have emerged as pervasive contaminants in coastal and marine environments, presenting significant environmental and ecological challenges. Although advancements have been made in the detection and classification of MPs, considerable knowledge gaps remain, particularly regarding their long-term ecological effects, pathways of exposure, environmental persistence, and implications for human health. In this light, the present review study aims to: (1) outline the primary sources and transport mechanisms of MPs within marine systems; (2) evaluate their potential risks to both ecosystems and human health; and (3) explore effective mitigation strategies to curb their environmental impact. Key sources of MPs include synthetic fibers from textiles, abrasion of vehicle tires, and fragmentation of consumer plastics. These particles are dispersed throughout marine systems by ocean currents, wind patterns, and biological vectors. Once introduced into marine food webs, MPs tend to bioaccumulate and bio-magnify, affecting various organisms. Their presence has been linked to adverse physiological effects, reproductive impairments, and altered behavior in marine species. Moreover, MPs can act as vectors for toxic chemicals, amplifying ecological risks by disrupting plant growth and animal health. Human exposure to MPs in marine ecosystems primarily via seafood consumption and ingestion of contaminated water raises pressing concerns about possible chronic health effects, which are not yet fully understood. These findings emphasize the urgency of implementing mitigation measures. For instance, this review presents prominent solutions that include strengthening waste management infrastructure, enacting robust policy and regulatory frameworks, and investing in scientific research and innovation. Ultimately, this review underscores that addressing microplastic pollution demands a collaborative, multi-scalar approach involving coordinated action across scientific, policy, and public domains extending from local efforts to international cooperation.

Keywords: Bioaccumulation; Human Exposure; Marine ecosystems; Microplastics (MPs); Mitigation

ICSBE25_556

PERFORMANCE OF CONSTRUCTION WASTE MATERIALS AS CORAL PLATE SUBSTRATES IN SHORT-TERM BIOFOULING ANALYSIS

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Abstract: Global coral reef degradation driven by climate change, coastal development, and pollution has increased the urgency for effective restoration strategies. A critical factor influencing coral recruitment on artificial substrates is the early stage of biofouling, particularly colonization by Crustose Coralline Algae (CCA), which provide settlement cues for coral larvae. In this study, we evaluated the suitability of construction waste materials as potential substrates for coral restoration, aligning with sustainable approaches to reuse industrial waste and derived byproducts. Experimental plates (10 × 10 cm) of concrete, brick, terracotta, and ceramic were prepared and deployed on shallow reef flats at Pareiwalla reef, Sri Lanka, for a three-month in situ trial. Biofouling development was monitored monthly using underwater photography and quantified via ImageJ analysis. Results indicated that substrate type significantly influenced biofouling composition. CCA cover was highest on roofing tiles and terracotta and coral rubble plates, while non-crustose coralline algae overgrowth dominated terracotta and porcelain substrates. Community diversity indices revealed distinct successional patterns across substrate types. The findings highlight that certain construction waste substrates can facilitate favourable biofouling communities for coral recruitment, offering both ecological and waste management benefits. This study emphasizes the potential of integrating sustainable material reuse with reef restoration practices, contributing to circular economy solutions for marine conservation.

Keywords: Biofouling; Construction Waste; Coral Restoration; Crustose Coralline Algae; Substrate Colonization; Sustainable Reef Rehabilitation

DIGITAL TRANSFORMATION IN SUSTAINABLE CONSTRUCTION

ICSBE25_072

ENHANCING THE QUALITY OF 3D RECONSTRUCTION OF STRUCTURES FROM SPHERICAL IMAGES USING IMAGE GENERATION MODELS

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Abstract: Image-based 3D reconstruction of structures has become an active area of research, beneficial for maintaining and managing aging infrastructure. Traditional methods relying on monocular cameras suffer from inconsistencies due to variations in photographers' skill levels, making reconstruction quality highly operator-dependent. To overcome this, spherical images, which capture a complete 360-degree view, offer potential advantages by minimizing dependency on the photographer's technique. However, spherical images commonly include unintended human subjects, negatively affecting reconstruction processes. This study addresses this challenge by integrating object detection and image generation techniques. Specifically, the proposed method employs an object detection model to identify human figures within spherical images, after which an image generation model performs inpainting to remove these identified regions. Subsequently, the processed images are utilized in Neural Radiance Fields (NeRF) to perform the 3D reconstruction. The effectiveness of this approach was validated through application to an actual structure using 342 spherical images. Results demonstrated that removing human figures from images enhanced the robustness and quality of camera pose estimation, leading to visually superior 3D reconstructions compared to images without this preprocessing step. The approach presented here highlights a promising avenue for improving the usability of spherical imagery in structural inspections, significantly reducing obstacles posed by unintended content. Consequently, the proposed methodology facilitates more reliable and efficient creation of accurate digital representations, positively impacting infrastructure management practices.

Keywords: 3D Reconstruction; Inpainting; Neural Radiance Fields; Object Detection; Spherical Image

ICSBE25_097

INVESTIGATION AND DEVELOPMENT OF THE MICRO-MODELLING OF STONE MASONRY HERITAGE BUILDINGS IN GALLE FORT, SRI LANKA

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Abstract: In this research, the Finite Element Modelling (FEM) is used to determine the structural performance of stone masonry heritage buildings in the Galle Fort, Sri Lanka. Most of the historic buildings in the Galle Fort are constructed from locally available materials, particularly Coral Reef Limestone (CRL) and sand binders. The FEM simulations were informed by material characterization, including density, Poisson's ratio, and Young's modulus, which were obtained through laboratory testing. The study reconstructs the masonry heritage structures of the Galle fort, with the aim of testing their performance against various retrofitting interventions through FEM. A parametric study also examined the impact of geometric alterations on the FEM models, particularly the effect on the stress-strain behaviour of the masonry assemblies under different loading conditions. The results helped explain the failure mechanisms of stone masonry, thereby enabling the development of appropriate retrofitting measures for old buildings. It was found that the adhesive material used on the historic buildings has a bulk density of 1720 kg/m^3, a Young's modulus of about 8.5 GPa, and a Poisson's ratio of 0.25-0.40. The FEM studies indicate that the modelling methodology can reproduce with great accuracy the existing architectural features of the Galle Fort, analyze their mechanical behaviour, and advise on relevant conservation actions. The paper, therefore, outlines a detailed process of FEM at Galle Fort and suggests practicable retrofitting measures to protect this and other similar heritage buildings against future generations.

Keywords: FEM; Finite Element Modelling; Galle Fort Historic Buildings; Galle Fort Material Properties; Historic Buildings Retrofitting

ICSBE25_229

MATLAB-BASED DIGITAL IMAGE CORRELATION MEASURING TOOL FOR LARGE OUT-OF-PLANE DEFORMATIONS

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Abstract: Full-field deformation measurements provide valuable information in understanding the mechanical behaviour of materials under various conditions, especially those that point measurements cannot offer. Digital Image Correlation has emerged as a promising technique for capturing full-field deformation measurements due to its ease of use, reliability and wider measurement range. However, the high capital costs of commercially available Digital Image Correlation systems have hindered the widespread adoption of this technique. Furthermore, although several open-source Digital Image Correlation software packages are available, most of them are primarily designed for general two-dimensional deformation measurements, and minimal effort has been made to capture large out-of-plane deformations. This paper presents an in-house developed three-dimensional full-field deformation measurement system that utilises MATLAB-based algorithms for image processing and analysis. The system is specifically designed to assess materials undergoing significant out-of-plane deformations. Uniaxial post-buckling tests were conducted on thin steel plate elements with two different geometries to obtain full-field out-of-plane deformation measurements, revealing the potential of the developed measuring system. The precision of the strain measurements generated was validated against the measurements acquired through standard contact-based measuring tools. A comprehensive comparison of the results established that the proposed system exhibits remarkable capability in generating precise full-field displacement maps in an orthogonal coordinate system.

Keywords: Computer Vision; Digital Image Correlation; Full-field Deformation Measurements; Out-of-plane Deformation; Stereo DIC

INDOOR ENVIRONMENTAL QUALITY AND OCCUPANT WELL-BEING

ICSBE25_105

WHY DOES LOW ANIMAL VISIBILITY NOT ALWAYS LESSEN ZOO VISITOR SATISFACTION?

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Abstract: The Visual Landscape experience at a zoological garden differs from that of a typical urban recreational landscape as it is primarily based on animal-integrated observation. The direct influence of animal visibility on visitor experience and unchanged visitor interest in less animal visibility of naturalistic enclosures were two contrasting visitor judgements identified through the literature. The lack of alignment is due to an isolated analysis of influential factors, necessitating a unified approach. In response, this study aims to provide a theoretical context to interpret those formerly identified visitor preferences. A visual landscape assessment was conducted focusing on four visual concepts: coherence, disturbance, visual scale, and imageability as a comparative study between Dehiwala and Pinnawala zoological gardens in Sri Lanka, representing the two domains of barren and naturalistic zoo designs, respectively. The study solely focused on visitor perspectives, excluding the consideration of landscape influence on animal welfare. A sample of general visitors (n = 45 visitors from each zoo, age 18-40) was assessed using an on-site questionnaire with a 4-point Likert scale. The findings revealed that the influence of high coherence, less disturbance and high imageability in naturalistic enclosures holds visitor interest even in less animal visibility conditions. The results also reflect that the impacts of coherence, disturbance and Imageability vary in response to the level of naturalism of the enclosure, while visual scale remains unaffected. The findings assist zoos in designing and organizing their visual landscapes wisely to enhance visitor interest. Constant microclimatic condition on survey days is recommended for future studies to ensure accuracy.

Keywords: Animal Enclosures; Naturalism; Visitor Experience; Visual Landscape; Visual Scale; Zoo

ICSBE25_159

ROOM-TEMPERATURE FORMALDEHYDE SENSING USING A CuO/Cu–Au COATED IDE SENSOR

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Abstract: The furniture industry uses formaldehyde (HCHO) as a raw material in the manufacture of resins and adhesives. Nevertheless, it is also identified as a Volatile Organic Compound (VOC), which is highly dangerous to human health. Long-term or extended exposure to formaldehyde may cause serious effects, especially to the vital organs like the kidneys and the nervous system. According to the European Commission's Regulation (EU) 2023/1464, from August 6, 2026, furniture and wood-based articles cannot be placed on the market if they release a formaldehyde concentration higher than 0.062 mg/m^3 (equivalent to 0.05 ppm) under specified test conditions, a threshold set to protect indoor air quality and consumer health. This research focuses on developing a room-temperature formaldehyde gas sensor using a CuO/Cu–Au coated Interdigitated Electrode (IDE) sensor. The Cu–Au coated IDE electrode is prepared using chemical etching and electroplating methods. Copper acetate monohydrate, isopropanol, and polyethylene glycol are used to synthesize the CuO sensing layer. CuO sol-gel is applied using spin coating and heated at 140–150 °C to produce the sensor. According to the UV-Vis spectroscopy band gap of the sensor, 2.26 eV, it exhibits semiconductor characteristics. The sensor shows an average response of 83.80% to 0.2 ml formaldehyde injection, and the response and recovery times are 172.845 s and 141.998 s, respectively. According to the I/V characteristics, the sensor current increases with the increase of the HCHO concentration (0.2-0.8 ml). That proves the sensor is effective for the room temperature operation without the external heat. Also, this method is a cost-effective method for indoor air quality monitoring.

Keywords: CuO/Cu Au-coated Sensor; Formaldehyde Detection; Interdigitated Electrode; Room-temperature Sensing; Sol-gel Synthesis

ICSBE25_210

THE STUDY ON THE APPLICATION OF PSYCHOLOGICAL THEORIES IN SUPERMARKET DESIGNS AND ITS IMPACT ON THE CONSUMER EXPERIENCE WITH SPECIAL REFERENCE TO SUPERMARKETS IN COLOMBO AREA

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Abstract: Contemporary supermarket design is not merely an exercise in functional architecture; it explores the intersection between psychology and the built environment. As integral parts of urban life, supermarkets significantly shape everyday human experiences, yet the depth and nature of this influence remain insufficiently defined, with questions about its impact on human wellbeing. This study examines how four psychological theories can inform supermarket architecture in Colombo to enrich consumer behaviour and overall experience, while also addressing the essential role of supermarkets in meeting the rising demand for diverse grocery shopping, where choice lies with the consumer. Six leading supermarket chains, Keells, Cargills, ARPICO, LAUGFS, GLOMARK, and SPAR, were selected as case studies due to their prominence in Colombo's retail sector, diverse services, and broad customer base. The theories explored include the biophilia hypothesis, which highlights humans possess an inherent affinity for nature; the prospect-refuge, which explains attraction to spaces offering both prospect (opportunities for observation and exploration) and refuge (areas of safety and security); The Sensory Design Theory emphasizes engaging multiple senses to create memorable experiences, and the Gestalt Theory explores how humans perceive and interpret visual elements as unified wholes rather than individual parts. Using a mixed-methods approach comprising literature review, case studies, surveys, interviews, observations, photographic analysis, and spatial examination, this research demonstrates how these frameworks can be embedded in supermarket design. The objectives are to identify relevant psychological theories, assess their spatial application, and propose strategies to strengthen consumer experience. Findings reveal that psychologically informed design enhances consumer experience by reducing stress, improving comfort, and encouraging exploration. Biophilic features, sensory strategies, prospect-refuge layouts, and Gestalt principles collectively contributed to greater satisfaction, longer dwell times, and stronger purchasing patterns. The study emphasizes the importance of evidence-based architectural design in creating retail spaces that balance commercial success with consumer well-being.

Keywords: Biophilia Hypothesis Theory; Gestalt Theory; Prospect-refuge Theory; Sensory Design Theory; Sri Lanka; Supermarket Design

ICSBE25_251

OPTIMIZING INDOOR PLANT SELECTION AND PLACEMENT FOR ENHANCED COOLING WITH SMART WATERING

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Abstract: This study investigates the implementation of smart watering as a passive cooling strategy by examining the combined impacts of indoor plant selection, placement optimization, and automated misting on temperature regulation. The experiment was conducted in two identical rooms: Room A, equipped with a smart watering system and strategically arranged plants, and Room B, maintained as a control without plants. Three indoor plant species with varying leaf sizes (small, medium, and large) were studied to assess their cooling performance and the ideal positioning for maximizing thermal comfort. Statistical investigation demonstrated that medium-leaf plants (e.g., *Sansevieria trifasciata*) consistently reduced room temperatures by 0.1 °C to 1.2 °C compared to Room B. In contrast, large-leaf plants showed lower cooling efficiency, while small-leaf plants produced intermediate effects. These findings indicate that not only leaf size but also species-specific characteristics determine plant species selection for temperature control, as these traits considerably influence cooling efficiency. Furthermore, positioning plants was found to have a significant impact on cooling efficiency. The highest temperature reduction occurred when plants were positioned between the room's center and the midpoint of the wall. Wall-adjacent placement provided moderate cooling effects, while the room center proved least effective. This study demonstrates how strategic plant selection, proper placement, and smart watering work together to improve indoor thermal comfort. The results offer support for sustainable architecture through an energy-efficient alternative to traditional cooling systems, highlighting the promise of biophilic architecture in climate-responsive building design.

Keywords: Indoor Cooling; Indoor Plants; Passive Cooling; Plant Placement; Smart Watering

ICSBE25_253

EVALUATING THE EFFECTIVENESS OF OUTDOOR SMART WATERING AS AN INDOOR PASSIVE COOLING STRATEGY

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Abstract: This study examines the efficacy of outdoor smart watering systems implemented on building exterior walls as a passive cooling strategy to mitigate indoor temperature increases. A controlled experimental framework was established, utilizing two structurally identical rooms—one equipped with an outdoor smart watering system (experimental room) and the other serving as an unwatered control. The smart watering system was programmed to activate at 30-minute intervals, with varying operational durations of 5 minutes (Case 2), 15 minutes (Case 3), and 25 minutes (Case 4) per cycle to assess differential cooling impacts. Temperature measurements were systematically collected using an integrated array of thermocouples, mercury thermometers, digital sensors, and infrared thermometers to record indoor air temperature, exterior wall surface temperature, and ambient environmental conditions. The findings suggest a statistically significant cooling effect due to the smart irrigation system, with quantifiable decreases in wall surface and indoor air temperatures. Most efficient cooling Performance was observed during the 25-minute irrigation duration (Case 4), which produced peak temperature reduction of 1.2 °C inside and 5 °C on the exterior surface of the wall compared to the control. Peak cooling efficacy coincided with periods of heightened solar radiation, especially around midday. Furthermore, the system also exhibited heightened water usage, finding an environmental compromise between the cooling benefit and resource conservation. These findings substantiate the viability of smart watering systems' potential to be an innovative passive cooling system, to be potentially applied to sustainable architectural design, and to contribute to the advancement of energy-efficient building technologies. This study addresses the ventilation potential of these systems to boost the urban climate. resilience amid escalating climate change challenges.

Keywords: Indoor Temperature; Indoor Thermal Comfort; Passive Cooling; Smart Watering

ICSBE25_261

EVALUATING THE EFFECTIVENESS OF A HYBRID SYSTEM FOR INDOOR COOLING, COMBINING SMART WATERING WITH A TRADITIONAL CEILING FAN

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Abstract: In Case 1, a preliminary comparison of the two rooms was made. In this case, the temperature variations in Room 1 (control) and Room 2 (experimental) were recorded without any intervention. The data served as the baseline for subsequent comparative analysis. In Case 2, the effect of smart watering was observed. In this case, 10 houseplants were placed in Room 2, and 300 ml of water was sprayed on their leaves every 30 minutes. In this case, Room 1 was left unchanged to isolate the effect of plant transpiration. This study assesses a hybrid cooling system that integrates a smart watering system coupled with a ceiling fan as an energy-efficient substitute for traditional air conditioning. The technology improves evaporative cooling via plants and utilizes airflow to sustainably lower indoor temperatures. Experiments contrasted an unaltered reference room with an experimental room featuring the hybrid configuration. Temperature measurements were obtained at 30-minute intervals across three fan speeds utilising sensors, a thermocouple, and a mercury thermometer. The results demonstrated uniform enhancements in cooling compared to the reference room. Case 4 (The fan speed was increased to level 03, with the same 30-minute watering schedule) exhibited optimal performance with an average cooling of 0.6 °C, although Case 2 (10 indoor plants were placed in Room 2, and 300 mL of water was sprayed on their leaves every 30 minutes) attained the most significant peak reduction of 1.5 °C. Excessive airflow (Case 5) (The fan was operated at maximum speed (level 05) alongside periodic watering) diminished evaporative efficiency, underscoring the necessity for balanced fan speeds. The device reduced indoor temperatures by an average of 0.5–1.6 °C, with maximum efficiency in the afternoon, coinciding with elevated external temperatures. The hybrid system provides an eco-friendly, energy-efficient cooling option for residential applications, mitigating the environmental and energy disadvantages of conventional air conditioning.

Keywords: Ceiling Fan; Hybrid Cooling Systems; Indoor Temperature Control; Smart Watering

ICSBE25_326

SCENARIO-BASED FIRE HAZARD MODELING OF A SMALL AIRCRAFT
A WORK IN PROGRESS STUDY

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Abstract: The paper presents a scenario-based case study of how fire hazards of a small commuter aircraft were modelled and analysed for life safety and comfort of occupants. A simulation using the CFAST program was performed on a computer model of such an aircraft. Both the cabin fuselage and cockpit are represented by two zones each, and conservation of mass and energy principles were used for the simulation model. Several scenarios were created using multiple possible locations of fire origins and various targets to figure out the fire spread throughout the aircraft. Levels of oxygen and carbon dioxide, as well as smoke distribution, are documented and compared to the accepted levels of the same in the literature for human exposure. The overall impact of the work presented is the application to aircrafts as a work in progress basis, of this study.

Keywords: Aircraft; Computer Modelling; Fire Hazards; Life Safety, Smoke Distribution

ICSBE25_328

POST-OCCUPANCY EVALUATION OF THERMAL COMFORT PERFORMANCE IN LEED CERTIFIED BUILDINGS: A CRITICAL ANALYSIS OF DESIGN INTENT VERSUS OCCUPANT EXPERIENCE IN TROPICAL INDUSTRIAL ENVIRONMENTS

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Abstract: The proliferation of LEED-certified industrial facilities in tropical developing economies has created an urgent need for systematic Post-occupancy Evaluation (POE) to validate the effectiveness of temperate-climate derived green building standards in hot-humid conditions. Despite significant investments in sustainable design, the gap between certification promises and actual occupant experiences remains poorly quantified, particularly in manufacturing environments where thermal comfort directly impacts productivity and worker well-being. This study presents a comprehensive post-occupancy evaluation of thermal comfort performance in a LEED Platinum-certified apparel manufacturing facility in Sri Lanka, examining the critical disconnect between design intent and actual user experience through rigorous mixed-methods assessment. A convergent parallel mixed-methods design was employed, integrating quantitative survey data from 180 stratified-sampled employees with qualitative insights from 21 semi-structured interviews. The evaluation framework incorporated validated thermal comfort assessment instruments, adaptive behaviour indices, and systematic design intent analysis. Statistical analyses included descriptive statistics, reliability assessment, correlation analysis, and structural equation modelling. Qualitative data underwent iterative thematic analysis using NVivo 12. Findings reveal a substantial performance gap between design predictions and actual thermal comfort delivery. While design documentation anticipated 90% thermal satisfaction rates, actual occupant satisfaction measured only 62% (gap = 28 percentage points, $p < 0.001$). The evaporative cooling system, despite meeting energy efficiency targets (40 ACH), achieved only 58% occupant satisfaction in production areas. Personal thermal control systems, designed as primary adaptive mechanisms, showed critical underutilization (34% adoption rate) due to inadequate user education and interface complexity. Paradoxically, naturally ventilated common areas achieved higher satisfaction rates (71%) than mechanically controlled spaces, suggesting that occupant agency supersedes optimal thermal conditions in satisfaction determination. This POE demonstrates fundamental limitations in applying temperate-climate LEED standards to tropical industrial contexts without significant adaptation. The study reveals that technological sophistication in thermal control systems may be less important than design simplicity, user education, and perceived occupant control. Key recommendations include climate-specific thermal comfort criteria development, mandatory POE protocols for LEED maintenance, and enhanced occupant engagement strategies. The findings contribute critical evidence for refining green building standards in tropical manufacturing environments while establishing robust POE methodologies for future research.

Keywords: Building Performance Assessment; Green Manufacturing; Leed Certification; Post-occupancy Evaluation; Thermal Comfort; Tropical Architecture; User Experience

ICSBE25_358

IMPACT OF ACTIVE AND PASSIVE DESIGN STRATEGIES FOR ENERGY EFFICIENCY IN GREEN BUILDINGS: INSIGHTS FROM A CASE STUDY

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Abstract: Thermal comfort in buildings refers to the condition in which occupants feel neither too hot nor too cold, but adore a balanced indoor climate that supports health, productivity, and overall well-being. This study evaluates the indoor environmental quality and energy performance of the Sri Lanka Centre for Development Facilitation (SLCDF) Building in Boralesgamuwa, focusing on the interaction between passive and active design features. Using occupant surveys, measurements on environmental parameters, and energy simulations in DesignBuilder (guided by ASHRAE 90.1 Appendix G), the research examines thermal comfort, air quality, lighting, and overall energy efficiency. Survey results from building occupants reveal that while air-conditioned spaces provide stable temperatures, they also lead to dryness and higher CO_2 levels, impacting thermal comfort and air quality. In contrast, naturally ventilated areas maintain fresher air but experience temperature fluctuations. Environmental measurements confirm that CO_2 levels in open spaces remain well below recommended thresholds, while air-conditioned zones show reduced ventilation effectiveness. Energy simulations compare the actual building's performance against a fully mechanically ventilated model. Results indicate that passive strategies reduce cooling loads by a significant margin, lowering overall energy consumption. However, challenges such as glare and humidity imbalance require further refinement. The study concludes that enhancing passive features with adaptive controls can improve both occupant comfort and energy efficiency. The study concludes that integrating passive features with adaptive operation can improve both comfort and energy efficiency. Observed relationships between measured environmental variables and occupant feedback highlight the importance of balanced ventilation and glare control. Recommendations include increasing fresh-air circulation in conditioned zones, mitigating glare through shading, and refining hybrid ventilation strategies for long-term sustainability.

Keywords: DesignBuilder Simulation; DesignBuilder; Energy Performance; Hybrid Ventilation; Passive Design Strategies; Thermal Comfort; Ventilation and Air-conditioning

ICSBE25_412

EXPLORING THE AFFECT OF ENVIRONMENTAL CHARACTERISTICS FOR CHILDREN WITH INTELLECTUAL DISABILITIES: TOWARDS INCLUSIVE THERAPEUTIC LANDSCAPE DESIGN IN A SPECIAL EDUCATIONAL INSTITUTE IN BADULLA, SRI LANKA.

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Abstract: The study about outdoor learning environments for children with Intellectual Disabilities (ID) in special education schools in Badulla, Sri Lanka. The objective is to recognize the impact of certain environmental qualities in sensory-behavioural reactions from children with Autism Spectrum Disorder (ASD), Attention-Deficit Hyperactivity Disorder (ADHD), and Down Syndrome (DS) to provide criteria for inclusive therapeutic landscapes. Through a quantitative approach, primary data were gathered from 36 students aged 6 - 18 years old based on instructors' structured one-on-one interviews and reports, in addition to behavioural observations. Self-reactions to seeing, hearing, feeling, and smelling were scored on a 5-point Likert-type scale and then compared by age and disability type using Kruskal-Wallis tests. Thus, the findings reveal that natural elements like tender greenery, visually shaded and plain spaces, calm down children and assist them to concentrate, more subtly so for ASD children. Sensitivities to auditory stimuli differ, with children with ASD and ADHD being distressed by sudden loud noises, whereas DS children are more tolerant. Tactile responses vary, since while children with ASD dislike rough textures, those with ADHD and DS respond positively to tactile play. There are long-term beneficial effects on being "on-nature" and have increased when the participants were on-foot, but short-term behaviour response to a pleasant fragrance-induced exposure was also found; comportment duration of passive presence increased with the stimulus time length, from 5 min in natural environments whereas fishermen stayed only for more than one minute in highly populated setting (Vollmer and Willemsen, 1998). The findings emphasize the importance of sensory-responsive, multi-sensory therapeutic settings which include soothing vegetation, optimum auditory buffering, clear tactile changes, and pleasant olfactory stimuli. This brings about a significant contribution, as this study offers a framework for landscape architects and teachers to develop inclusive outdoor environments that promote holistic development in children with ID.

Keywords: Attention-Deficit Hyperactivity Disorder; Autism Spectrum Disorder; Down Syndrome; Intellectual disabilities; Outdoor Environment; Therapeutic Landscape Design

POLICY AND GOVERNANCE FOR SUSTAINABLE BUILT ENVIRONMENTS

ICSBE25_005

THE ROLE OF STOCK EXCHANGES IN PROMOTING THE BANKING SECTOR IN ADOPTING GREEN FINANCE

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Abstract: Over the last 50 years, the field of finance has evolved from three traditional pillars to include a fourth critical pillar to ensure planetary survival, sustainable finance. The urgency to transition from traditional finance to sustainable finance has never been greater, as climate change accelerates, regulatory pressures intensify globally, with developing economies further falling into poverty with increasing biodiversity loss, and investors increasingly face a lack of market transparency and demand environmentally and socially responsible portfolios to mitigate long-term risks and secure equitable economic growth. This paper examines the increasing need for cohesion required by stock exchanges, governments and banks in pushing their economies towards following the pathways towards limiting the rise of global temperatures to below 1.5 °C and achieving the 2050 goal of Net-Zero. By synthesizing over 64 sources, the study further focuses on scaling sustainable financial instruments and provides an overview of both the financial and sustainability industries. This research study sets an agenda for scaling sustainable finance in the 21st century.

Keywords: Climate Finance; Emerging Markets; ESG Adoption; Financial Regulation; Green Finance; Stock Exchanges; Sustainable Banking

ICSBE25_024

DETERMINATION OF ENVIRONMENTAL DEGRADATION DUE TO LAND-BASED SAND EXCAVATION IN THE AMBALANTOTA DIVISIONAL SECRETARY AREA

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Abstract: Sand is a crucial raw material for Sri Lanka's construction industry. With the continuous rise in demand for sand, inland sand mining, locally known as "Goda Valley" sand, has become an alternative to traditional river sand. Both bare and agricultural lands are used for this large-scale sand mining with leading to significant environmental degradation. This study assessed the environmental impacts of inland sand mining in sedimentary sand deposited locations situated in the Ambalantota divisional secretary area. Through field observations, secondary data analysis, and expert input, the study evaluates both the negative and positive environmental consequences, focusing on key parameters such as land, water, soil, biodiversity, noise, and local quality of life. Both active and abandoned mining sites were assessed. The most critical environmental damage is observed as land degradation. Large-scale excavation, exceeding approved boundaries, left deep unfilled pits that have changed the natural topography and reduced the land usability. Many abandoned pits have now turned into stagnant water bodies. Water is also significantly affected by exposure and the lowering of groundwater levels, with the risk of contamination. Additionally, soil fertility has also declined due to the removal of topsoil and poor land reclamation practices. Despite these challenges, the study also found efforts to reuse some abandoned sites for banana cultivation and aquaculture, providing alternative livelihoods. The research proposes practical and sustainable impact recovery methods, including organic waste-based landfilling and expanding aquaculture with the support of institutions such as the National Aquaculture Development Authority (NAQDA). The consequences of the prevailing condition of the sand mining activities have not yet been properly documented. Therefore, this study provides valuable insights for policymakers, environmental authorities, and local communities by offering feasible solutions to rehabilitate degraded land while supporting local livelihoods.

Keywords: Abandoned Sites; Environmental Impact; Inland Sand Mining; Land Degradation

ICSBE25_154

ADVANCING GREEN AND SUSTAINABLE BUSINESS PRACTICES THROUGH COMPOSITE FLIGHT SAFETY SCORING: A SWISS CHEESE MODEL-BASED APPROACH

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Abstract: Sustainability in the global aviation sector no longer needs to function in a siloed manner; rather, it must incorporate long-term strength, safety, environmental stewardship, and economic efficiency. By creating an integrated flight safety score based on the Swiss Cheese Model of accident causation, this study suggests a green and sustainable business model. The study highlights how flight-based safety score can support environmentally and economically sustainable airline systems, and it was prompted by recent high-profile air accidents like Jeju Air Flight 7C2216 (2024) and Air India Flight A1171 (2025). To determine a standard risk score (1 to 5) per flight operation, the model combines three important factors: pilot flying hours (human performance), ICAO USOAP audit scores (regulatory management), and aircraft physical condition (age, technological maturity, and prior safety). The study employs a quantitative research design to measure operational risk at the individual flight level using real-world data from Sri Lankan Airlines, the ICAO, and international aircraft registers. From the standpoint of a green business model, the model improves sustainability in a number of ways. By making well-informed decisions that support carbon-reduction goals, airlines increase fleet efficiency, decrease fuel-guzzling flight patterns, and prolong aircraft lives. Adopting evidence-based risk profiles to permit reduced claims rates and rewarding environmentally friendly behaviour by funding sustainable premium models provide incentives for insurers. Promoting greener innovations and advocating for designs' long-term safety, durability, and environmental performance gives aircraft manufacturers a competitive edge. This safety scoring system is a creative, empirically supported approach to mainstreaming safety in green aviation policy. It is furthering global sustainability agendas by promoting safe skies, reducing unnecessary environmental harm through effective flight operations, and cultivating accountability and transparency throughout the aviation value chain.

Keywords: Aviation Sustainability; Green aviation; Sustainable Business Model; Swiss Cheese Model

ICSBE25_238

COMPARATIVE CHEMICAL AND MORPHOLOGICAL ANALYSIS OF PASSIVE SAMPLED AIRBORNE PARTICULATE MATTER ACROSS DIVERSE ENVIRONMENTS IN SRI LANKA USING FTIR, TGA, AND SEM-EDX TECHNIQUES

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Abstract: Airborne Particulate Matter (PM) presents serious environmental and public health challenges in rapidly urbanizing and industrializing regions with limited air quality monitoring, such as Sri Lanka. While size-based PM classification (e.g., PM_{10}, $PM_{2.5}$) is well established, limited attention has been given to its chemical composition and morphology, which are critical for source identification and toxicology assessment. This study applies a cost-effective framework combining bulk and particle-level characterization of passively sampled PM across seven diverse environments in Sri Lanka. This approach can serve as a screening-level tool to identify potentially hazardous particles, which can be prioritized for further investigation using advanced techniques. PM samples collected over a period, at breathing height (~1.5 m), were analysed using Fourier Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), and Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM-EDX). FTIR spectra commonly showed aliphatic C–H stretching (~2920 cm^{-1}), silicate-associated Si–O stretching (900-1030 cm^{-1}), and carbonate bands (~870 cm^{-1}). Urban and plastic recycling sites exhibited strong carbonaceous signals, while inorganic features dominated quarry, beachfront, and concrete processing locations. TGA revealed gradual weight loss in organic-rich samples and minimal degradation in inorganic-dominant samples. Final residues exceeded 90% at the quarry and concrete sites, compared to ~65% in carbon-dominant samples. SEM-EDX revealed diverse particle morphologies, including rounded, irregular, elongated, and aggregated structures with smooth and rough surfaces. Plastic recycling and urban traffic sites showed C-rich particles with clustered and irregular forms, indicative of anthropogenic origins. Concrete samples contained C, O, Ca, Si, and Al, consistent with cement dust. Quarry samples showed Si, K, Ca, and Fe, and coastal samples included Na, Si, Ca, and carbonate-rich particles resembling sea salt and mineral grains. Notably, the low-emission natural site exhibited biological particles, suggesting biogenic origins. The results reveal distinct PM profiles across environments, highlighting the need for site-specific characterization. This supports the proposed low-cost framework for preliminary screening in low-resource settings.

Keywords: FTIR; Particulate Matter; Passive Sampling; SEM-EDX; TGA

ICSBE25_250

EVALUATING THE EFFECTIVENESS OF INDOOR SMART WATERING FOR ROOM TEMPERATURE REDUCTION

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Abstract: This research employs a controlled experimental methodology to assess the effectiveness of a smart indoor watering system in reducing room temperature. Two identical rooms with similar dimensions, orientation, and interior design were selected based on prior research. While the experimental room was furnished with specific indoor plants and observed using mercury thermometers, thermocouple meters, and portable temperature sensors, the reference room stayed unaltered. Significant improvements over earlier techniques can be seen in the use of foam boards for insulation, thermocouples for precise air temperature measurement, and spray bottles for water misting to improve evaporative cooling. Throughout the experiment, which ran from 7:00 AM to 6:00 PM, temperature readings were taken at various levels and locations. Water volumes ranging from 100 to 300 milliliters and ten to twenty plants were examined. The findings showed a notable improvement in cooling with increasing water volume, with 250 ml and 300 ml water volumes achieving temperatures up to 1.5 °C lower than the surrounding air temperature. Likewise, the inclusion. In a similar vein, adding more plants enhanced the cooling effects; 20 plants reduced the temperature by up to 2.3 °C when compared to the outside environment. The results show that through better leaf and evaporative cooling mechanisms, more indoor plants and more water can significantly improve thermal comfort in enclosed spaces. Similarly, the addition of more plants improved cooling effects, with 20 plants resulting in a temperature reduction of up to 2.3 °C compared to the external environment. The findings indicate that an increased number of indoor plants and a greater water volume can substantially enhance thermal comfort in enclosed spaces through improved leaf and evaporative cooling mechanisms.

Keywords: Evaporative Cooling; Indoor Plants; Passive Cooling; Smart Watering

ICSBE25_289

A STUDY ON ENVIRONMENTAL AWARENESS ATTITUDES AND PRACTICES AMONG THE SECONDARY LEVEL SCHOOL STUDENTS IN RATHNAPURA DISTRICT.

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Abstract: Environmental degradation is one of the major problems in the world. In this scenario, the importance and need for environmental education as a tool for environmental management and conservation cannot be overemphasized. This study investigates the environmental awareness, attitudes, and participation in environmental activities among the secondary level school students in the Rathnapura district, Sri Lanka. A total of 800 secondary school students were randomly selected for the study. Data were collected through a structured questionnaire administered by teachers to minimize bias. This research was focused on students' awareness of environmental issues, their attitudes toward environmental protection, and their involvement in environmental activities. The study utilized both qualitative and quantitative data analysis techniques. Descriptive statistics methods were used to summarize the data, while inferential statistical tests determined the significance of differences in awareness, attitudes, and participation across different student groups. The results provide a comprehensive understanding of the environmental perception of secondary level school students in Rathnapura, offering insights into potential areas for enhancing environmental education and participation in the district. Analysis of the data was done using SPSS. By calculating an Analysis of Variance (ANOVA) and a group statistic using $P = 0.05$, the hypotheses postulated were tested and it was established that there is no significant difference, environmental awareness, attitude and level of participation in environmental activities of secondary level female and male students in Rathnapura District. But it was evident that students had a very low level of awareness of current and emergent environmental problems and concepts. Overall results obtained in the study thus indicate that there is no significant difference in the level of environmental awareness, attitudes and participation in environmental activities among the female and male students in Rathnapura district.

Keywords: Attitude; Awareness; Environment; Practices; Secondary Level Students

ICSBE25_298

INTEGRATED CONSERVATION AND DEVELOPMENT FRAMEWORK FOR BUFFER ZONE MANAGEMENT BALANCING SETTLEMENT EXPANSION AND ECOSYSTEM PRESERVATION IN PROTECTED AREAS – SRI LANKA

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Abstract: The expansion of human settlements near protected areas poses threats to biodiversity by encroaching on buffer zones, which are critical interfaces that mitigate the adverse effects of human activities on protected areas, such as National parks. In Sri Lanka, managing these zones is challenging due to competing development pressures and limited public awareness of their ecological importance. This study proposes an integrated conservation and development framework for effective buffer zone management that balances the expansion of settlements with ecosystem preservation. The study focused on the buffer area of the Wilpattu National Park and assessed the ecological impacts of human settlement and community involvement. A mixed-methods approach was adopted, combining mapping, literature reviews, and interviews with local stakeholders to evaluate the effectiveness of existing management strategies and identify key conflicts between development and conservation. Findings revealed that while buffer zones contribute positively to conservation outcomes, their effectiveness is hampered by insufficient local awareness and unregulated land use practices. The study recommends strategic approaches, including enhanced community engagement, sustainable land-use planning, and improved change-management preparedness, to ensure sustainable development within buffer zones. The proposed framework is adaptable to other protected areas in Sri Lanka and similar Landscapes and offers practical recommendations for policymakers, conservation practitioners, and landscape architects. By integrating ecological and socio-economic considerations, this research contributes to the development of a more sustainable buffer zone governance.

Keywords: Buffer Zone Management; Ecosystem Preservation; Human Settlement Expansion; Protected Areas; Sustainable Development

ICSBE25_406

FIRE SAFETY IN HIGH-RISE BUILDINGS IN SRI LANKA: AN ANALYSIS OF THE PERMIT GRANTING PROCESS, STAKEHOLDER ROLES, AND PRACTICAL COMPARISON BETWEEN SRI LANKA AND UK

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Abstract: In the Sri Lankan context, a high-rise building can be defined as any building with a height above the ground level that exceeds 30 meters. The rapid increase of urban development and population growth led to construct of many high-rise buildings in Sri Lanka. The fire safety has become a critical concern in high-rise buildings, as it serves as a safeguard against the loss of lives, disruption of economic and social activities. Fire safety precautions must be included throughout the building lifecycle, from the building planning stage to the maintenance stage. This study investigates the effectiveness of the current fire safety permission-granting process for a high-rise building in Sri Lanka. A mixed method approach was conducted, including the document reviews, stakeholder interviews and questionnaire surveys. The procedural steps for the fire safety permission-granting process for a high-rise building were verified, including the responsible authorities. Descriptive and statistical analysis revealed that, the limited stakeholder awareness of the fire safety requirements. Many projects are proceeding without the involvement of professional fire engineers. Findings also highlighted inefficiencies within the approval process, particularly at the Preliminary Planning Clearance (PPC), Building Approval (BA), and Certificate of Conformity (CoC) phases. While some authorities prefer online submission portals, gaps remained for the stakeholders with limited IT literacy. Comparative analysis underscored the differences in the fire risk assessment process and the regulatory frameworks between Sri Lanka and the United Kingdom. In the UK, fire safety follows several regulations, including Building Regulations 2010, Fire Safety Act 2021 and 2022. The UK adopts a five-step fire risk assessment process, while Sri Lanka is not following a comprehensive assessment of fire risk levels. The research identifies urgent needs for a centralized regulatory procedure and an enhanced professional capacity to align the fire safety framework of Sri Lanka.

Keywords: Fire Safety Regulations; Fire Safety; High-rise Buildings; Permit Granting; Stakeholder Awareness

ICSBE25_444

FACTORS AFFECTING LAND ACQUISITION TIME IN GOVERNMENT-OWNED DRINKING WATER SUPPLY PROJECTS IN SRI LANKA

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Abstract: Despite the presence of standardized procedures established by the National Water Supply and Drainage Board (NWSDB), large-scale drinking water supply projects in Sri Lanka are frequently subject to delays, with prolonged private land acquisition processes emerging as one of the most critical bottlenecks. The delay in project completion can also hinder the timely delivery of safe drinking water to communities, thereby undermining national development priorities and public welfare. This study investigates the underlying causes of land acquisition delays through an in-depth case study of the Kandy North & Pathadumbara Integrated Water Supply Project. A qualitative research design was employed, combining purposive and snowball sampling strategies to conduct eight expert interviews with key stakeholders directly involved in project implementation. The data were analyzed using thematic coding techniques to identify recurring patterns, interrelationships, and root causes of delay. The analysis revealed seven broad categories of influential factors: (i) Legal and Constitutional Framework, (ii) Governance System, (iii) Compensation Mechanisms, (iv) Socioeconomic and Political Conditions, (v) Institutional Arrangements, (vi) NWSDB Internal System, and (vii) Technology-Related Factors. Among these, the last three categories were found to be uniquely significant within the Sri Lankan context when compared to international experiences. The findings provide actionable insights for policymakers, land administration authorities, and development agencies, emphasizing the need for streamlined processes, improved inter-agency coordination, and institutional reforms.

Keywords: Drinking Water Supply Projects; Governance System; Land Acquisition; Technology

ICSBE25_552

PROMOTING ENERGY EFFICIENCY BUILDING CODES IN SRI LANKA COMPARATIVE INSIGHTS FROM EQUATORIAL COUNTRIES AND STRATEGIC PATHWAYS FOR IMPLEMENTATION

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Abstract: The Energy Efficiency Building Code (EEBC 2021) of Sri Lanka is a vital step towards reducing the country to low-carbon and climate-resilient development. To a large extent, the implementation and enforcement of the EEBC have not been realized following its introduction, especially due to institutional fragmentation, inappropriate financial mechanisms, and ineffective technical capacity in the entire construction industry. This paper uses a comparative policy analysis that is based on qualitative analysis of the ways in which the chosen countries of the equator, Singapore, Malaysia, and Indonesia have progressed in energy-efficient building codes and what policy implications can be transferred to Sri Lanka. Policy papers, code compliance reports, and international agency publications from 2015 to 2025 were searched using a systematic document review. The study is based on a conceptual framework derived from the Institutional Capacity Theory and the Policy Diffusion Framework, whereby barriers, enabling strategies, and anticipated implementation output are linked. Results indicate that even though policy intentions in Sri Lanka align with the global energy efficiency goals, it is facing challenges of code enforcement, inter-agency coordination, and performance monitoring. As observed in comparative analysis, prosperity in other countries such as Singapore and Malaysia is attributed to effective governance systems, regulatory frameworks that are incentive-based and compulsory compliance monitoring systems. Based on these insights, the paper suggests the strategic routes that Sri Lanka can take to achieve high-efficiency standards of the EEBC, such as the introduction of a central compliance body, the capacity-building of the local authorities, and financial incentives related to the compliance of the developers with the high-efficiency standards. The research innovates the growing body of evidence concerning sustainable, energy-efficient and climate-responsive building regulation in tropical developing countries on the regional level.

Keywords: Climate-responsive Design; Comparative Policy Analysis; Energy Efficiency Building Code (EEBC); Energy Policy Implementation; Equatorial Countries; Institutional Capacity; Sri Lanka; Sustainable Building

DISASTER RISK REDUCTION AND RESILIENT INFRASTRUCTURE

ICSBE25_066

DEEP LEARNING-BASED SEGMENTATION OF AERIAL IMAGERY FOR BRIDGE DAMAGE ASSESSMENT

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Abstract: The functionality of transportation infrastructure, particularly bridges, is critical for effective emergency response and rapid recovery efforts following a major natural disaster. This study aims to develop a high-precision segmentation method that utilizes deep learning techniques to automatically detect bridges and classify their damage status from post-disaster aerial imagery. Our proposed method employs the YOLOv8 architecture, which achieves an excellent balance of accuracy and speed for object detection and instance segmentation tasks. The model is trained to classify bridges at the pixel level into two categories: "damaged" and "undamaged." To train the model, we used a dataset of aerial photographs taken during the 2011 Great East Japan Earthquake and the 2024 Noto Peninsula Earthquake. Data augmentation techniques were applied to the images of damaged bridges, the minority class, to enhance the model's generalization capabilities. Evaluation of the trained model on an unseen validation dataset confirmed its ability to effectively detect and classify targets. The model demonstrated success in properly identifying damaged bridge areas even under challenging conditions, such as when debris was scattered on the deck. Quantitative evaluation showed a high precision of 0.5688 for the damaged class, confirming the reliability of positive detections. The model's tendency to only partially segment heavily damaged bridges resulted in a lower recall (0.3558); however, this study reveals this "partial detection" characteristic to be a valuable signal in itself. It confirms the method’s effectiveness as a primary screening tool for rapidly locating damaged infrastructure. Furthermore, this unique detection behaviour opens a new avenue for research where shape analysis of the segmented regions could be leveraged for more advanced damage assessment.

Keywords: Aerial Imagery; Bridge Damage Segmentation; Deep Learning; Disaster Management; YOLOv8

ICSBE25_081

ASSESSMENT OF THE DRAINAGE SYSTEM USING THE STORMWATER MANAGEMENT MODEL

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Abstract: In urban areas, flash flood is a significant issue caused by high-intensity rainfall duration and other factors such as impervious surfaces, inadequate stormwater drainage performance, unauthorised urban development, and climate change. These issues led to an increase in the flood level in urban areas and worsened living conditions for humans. Effective use of stormwater Best Management Practices (BMPs) reduces the runoff volume, flow velocity, and pollutant load. BMPs are a key component of low-impact developments and practical, effective methods such as green roofs, permeable pavements, rain barrels, and detention and retention ponds. The study was conducted in the Deiyyannawela catchment, Kandy, in Sri Lanka, an area regularly affected by flash floods for many years, for short-duration, high-intensity rainfall events. This study aims to minimise flash floods by using the stormwater management concepts and to assess the stormwater drainage system. For this study main objectives were to systematically evaluate the applicability and effectiveness of various best management practices for mitigating the flash flood risk in the catchment area and to evaluate the performance of BMPs through a Stormwater Management System (SWMS) model. In this study, the data were collected through both a field survey and a social survey targeting the individuals in the affected area. The collected data mainly focuses on the drainage measurements and understanding the community experience, and the historical knowledge of flood occurrences. These collected data are integrated and analysed with ArcGIS for spatial mapping and data visualisation, while the SWMM (Storm Water Management Model) software is used to simulate and assess the hydrological behaviour of the area. The findings provide that the detention pond was the most effective and performable Best Management Practice, and there were two detention ponds integrated in the catchment, and which reduced 46.78% stormwater runoff during a high-intensity rainfall event.

Keywords: Best Management Practices (BMPs); Drainage Performance; Flash Flood; Stormwater Management; SWMM (Storm Water Management Model)

ICSBE25_129

INFLUENCE OF CLIMATE CHANGE ON FOREST FIRE OCCURRENCE AND DISTRIBUTION OF SRI LANKA AND MODELING OF FOREST FIRE

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Abstract: Forest fires have been a significant threat to the conservation of forest resources in Sri Lanka. Forest fire modeling is a novel technique used to study and predict the behavior of forest fires. This study uses simulation techniques to investigate the relationship between forest fire occurrence and climate change, particularly in the Dry Zone of Sri Lanka. Level of occurrences and the duration of the phenomena of sea current oscillation, like *El Niño* Southern oscillation (ENSO), change due to climate change, which will be resulted to create extreme dry conditions that enhance intensified fire risks, particularly in the dry zone of Sri Lanka. To assess fire vulnerability under prevailing weather conditions and a projected climate change scenario, the FConstMTT simulation algorithm was used with 1,000 iterations per scenario. In this analysis, forest types across Sri Lanka were categorized into six classes based on elevation, rainfall, and fuel characteristics, with customized fuel models created using BehavePlus and spatial data processed through the ArcFuel extension of ArcGIS. Results indicate that under projected climate scenarios, fire hazards in the dry zone, particularly in districts Mullaitivu, Monaragala, Anuradhapura, Polonnaruwa, and Badulla, are likely to worsen in the future. In climate change scenarios, Monaragala District accounts for about 53% of total fire damage, with Badulla District showing a significant baseline vulnerability. Based on fire frequency and intensity, 25 administrative districts in Sri Lanka were categorized into high, moderate, and low-risk areas. Forest types like dry monsoon forests, shrublands, open forests, and savannahs are particularly vulnerable under predicted climate change scenarios.

Keywords: ArcFuel; Climate Change; Dry Monsoon Forest; FConsMTT; Fire Simulation

ICSBE25_131

ASSESSMENT OF SPATIAL AND TEMPORAL CHANGES IN LAND USE AND LAND COVER IN DAMBULLA DSD FROM 1985 TO 2020.

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Abstract: Land cover can be recognized as a limited and rapidly depleting resource in the world. Land use changes are occurring globally due to deforestation, overharvesting, urbanization, agricultural expansion, population growth and other similar factors. Land use change has become a pressing issue in Sri Lanka that requires immediate attention. Therefore, a study has been carried out with the objective of identifying the temporal and spatial dynamics of land use and land cover in Dambulla DSD from 1985-2020. The methodology adopted a comprehensive approach, integrating RS data and GIS, specifically leveraging Google Earth Pro and ArcGIS for the generation and analysis of land use and land cover maps pertaining to 1985, 2001, 2006, and 2018. This empirical mapping was augmented by an extensive review of historical data, governmental policies, and reports from key institutions, including the LUPPD and the study is mainly based on secondary data. According to the analysis, seven (07) land use and land cover categories were identified, namely Agricultural Lands, Barren Lands, Forests, Buildup Areas, Water bodies with an Increasing trend, decreasing trend, no change and extinction. As per analysis, built-up areas (10.2%) and agricultural lands (25.5%) marked a remarkable increasing trend (15.3%) while wetlands (12.8%) and forest cover (20.5%) marked a declining trend (7.7%) during this period. Between 2001 and 2018, approximately 68.4% of the Agricultural land in Dambulla DSD remained unchanged, while about 4.6% of natural land categories, such as wetlands and forests, were completely lost. These land use and land cover changes have caused problems like loss of biodiversity, water shortages, and human-animal conflicts. Furthermore, persistent population growth and the proliferation of informal land use patterns contribute to increased vulnerability to natural disasters. To deal with these serious problems, the study suggests several ways to manage land better and support farming. These include protecting lake areas, planting trees around reserves, and improving water systems. If these steps are followed, the Dambulla area can reduce harmful land use and move toward a greener and stronger future for both nature and people.

Keywords: Agricultural Expansion; Biodiversity Loss; Human-animal Conflicts; Land Use and Land Cover; Water Shortages

ICSBE25_139

BIO-ENGINEERING: CLIMATE RESILIENCY MEASURES FOR ROADS IN NEPAL

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Abstract: Nepal is vulnerable to disasters, such as intense rainfall, floods and landslides. The large quantities of runoff due to intense rainfall during the four months of monsoon season induce erosion, debris flow and landslides through heavy storms. Nepal is one of the most vulnerable countries in the world regarding climate change impacts. It is also affecting the stability of steep slopes of Nepalese mountains through heavy floods and believed that the impacts will worsen in the future. Climate pattern study shows that precipitation patterns have changed and that there is more risk of erratic rainfall giving rise to massive erosion and heavy landslides. Climate change is causing a rapid increase in the number and size of Himalayan glacial lakes, giving potential threats of Glacial Lake Outburst Floods (GLOF) affecting the rivers. The intensified floods trigger landslides on the mountain roads and flooding on the plain roads, disrupting access to transport services. The earthwork excavation and filling during road construction in the mountains disturb the stable slopes. It also damages vegetation, causing various adverse environmental impacts. Despite these challenges, the road agencies are increasingly required to respond and mitigate the impacts of climate change. The aim is the provision of reliable access to reduce operating costs and promote substantial growth for greater economic activity and social interaction. It is necessary to understand the climate change challenges, the adaptation and resilient measures. Proper selection of alignment, drainage capacity design and slope protection techniques are very important for low maintenance and sustainability of mountain roads. Attention is needed in careful disposal of spoil, longitudinal side drainage, cross drainage, road surface and sub-surface drainage management. Special care should be taken in selecting the type of slope stabilization measures and design during the road construction stage to ensure the stability of roadside slopes. In the climate change contest, the road transport structures should be designed to be more resilient to prevent the increased risk of erosion, landslide and flooding. The bio-engineering techniques developed in Nepal are simple, cost-effective and provide Nature-based Solution (NbS) for road construction and maintenance. Nepal has started the use of roadside bio-engineering during the construction and maintenance of roads by introducing the engineering design norms and specifications, training manuals and policy documents. Bio-engineering procedure is labour-intensive, which provides employment to the local community. The use of bio-engineering structures integrated with civil engineering structures in mountain roads has proved to be cost-effective, environmentally friendly and resilient measures for erosion control and landslide protection.

Keywords: Bio-engineering; Climate Change; Landslides; Mountain Roads; Nature-based Solution (NbS); Resiliency

ICSBE25_144

MORPHOLOGICAL EVOLUTION AND EROSION VULNERABILITY ASSESSMENT OF THE DEDURU OYA RIVER USING REMOTE SENSING AND GOOGLE EARTH ENGINE, SRI LANKA

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Abstract: The Deduru Oya River in Sri Lanka exhibits dynamic morphological changes driven by fluvial processes and human interventions, with direct implications for downstream ecosystems, land use, and flood risk. This paper analyzes the morphological evolution of the downstream stretch of Deduru Oya between 2015 and 2025 using freely available Sentinel-2 and Landsat satellite data processed on the Google Earth Engine (GEE) platform. Key morphometric indicators: river sinuosity, meander development, sediment bar aspect ratio and sediment bar area were extracted at selected locations using annual cloud-filtered image composites. The results indicate spatially heterogeneous but systematically increasing sinuosity, with the estuarine reach showing the strongest meander growth, and a redistribution of sediment bar area between Wilattawa (near the reservoir) and downstream Weherakele sites. These findings highlight erosion-prone and morphologically sensitive zones that are of concern for bank stability and local communities. While the number of temporal samples and usable images is limited by cloud cover and data availability, the study demonstrates how open-access satellite archives and cloud-based processing can provide a reproducible framework for monitoring fluvial dynamics in a data-scarce tropical basin. The work also outlines potential extensions using additional open satellite missions, improved pre-processing and feature-extraction techniques, and closer integration with field observations to support evidence-based river management in the Deduru Oya catchment.

Keywords: Deduru Oya River; Google Earth Engine; Landsat; Sediment Bar; Sentinel-2; Sinuosity

ICSBE25_147

EVALUATE THE IMPACT ON THE WEST COAST DUE TO THE CONSTRUCTION OF SOUTH PORT BREAKWATER OF COLOMBO HARBOUR

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Abstract: The South Port Breakwater of Colombo Harbour, built as part of Sri Lanka's port expansion, has greatly affected the natural flow of sediment down the west coast, having a significant impact on the surrounding shorelines of Mount Lavinia and Crow Island Beaches. Using high-resolution Google Earth satellite imagery covering the northeast monsoon (October–January) and southwest monsoon (May–September) prior to and post construction, this study evaluates corresponding coastline changes using a geospatial approach. Transects were positioned at 50-meter intervals along a baseline of 2000 meters, and shorelines were digitalized and examined in QGIS using the QSCAT (QGIS Shoreline Change Analysis Tool) plugin. To quantify patterns of erosion and accretion, three important shoreline change indicators were computed: Shoreline Change Envelope (SCE), Net Shoreline Movement (NSM), and End Point Rate (EPR). The findings demonstrated that, especially during the southwest monsoon, Crow Island Beach observed significant sediment accretion after breakwater construction, with SCE values going over 66.95 m and EPR reaching + 10.73m/year. Reduced wave energy and sediment entrapment in the buffer zone behind the breakwater are the causes of this accretion. On the other hand, Mount Lavinia Beach showed more severe erosion patterns, particularly during the southwest monsoon, with NSM dropping by more than −22 m in certain places and EPR values dropping to −8.86 m/year. These diverse findings show that the shoreline reaction is geographically unequal, reflecting the impact of longshore sediment transport and how seasonal monsoon dynamics influence it. It also highlights the significance of adaptive management techniques, continuous shoreline monitoring, and integrated sediment transport models in decreasing unintended impacts of coastal infrastructure development and enhancing shoreline resilience.

Keywords: Coastal Erosion; Monsoon Impacts; QGIS; Sediment Transport; Shoreline Change; South Port Breakwater

ICSBE25_162

EVALUATION OF STRUCTURAL INTERVENTIONS FOR FLOOD RESILIENCE IN THE COLOMBO METROPOLITAN REGION, SRI LANKA, USING TWO-DIMENSIONAL FLOOD MODELING

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Abstract: The Colombo metropolitan region, the densely urbanized capital area of Sri Lanka, frequently experiences severe flooding, highlighting the urgent need for effective flood management strategies to support sustainable development. Climate change and rapid urbanization are expected to intensify these flood challenges. In response, several structural flood management interventions have been proposed and are being implemented to mitigate flood risks and enhance resilience in the Metro Colombo basin. This study developed a high-resolution, two-dimensional hydrodynamic model using HEC-RAS for the Lower Kelani Basin, including the Metro Colombo sub-basin, to evaluate the integrated impact and effectiveness of six key flood management measures, comprising the introduction of pumping stations, new outfalls, diversion schemes, a tunnel, and widening of existing outfalls. Model simulations were conducted for two scenarios representing 50-year return period rainfall events under both unfavourable (high) and favourable (low) discharge boundary conditions of the Kelani River, as well as the actual flood event of 2016 May. Under the 50-year return period rainfall with unfavourable boundary conditions, the interventions reduced the inundation extent by 41.5%. For favourable conditions, the extent of flooding was nearly halved, with floodwater levels falling below critical safety thresholds throughout the Metro Colombo basin. The application of the interventions to the 2016 May flood event resulted in a 48.1% reduction in flood inundation area and a significant decrease in floodwater levels, keeping water levels below flood safety thresholds. These results demonstrate that engineered flood management interventions can substantially reduce flood risks in urban environments such as Metro Colombo, supporting both flood resilience and sustainable urban development.

Keywords: Flood Management; Flood Risk; Interventions; Metro Colombo Basin; Sustainable Urban Development; Urban Floods

ICSBE25_186

SHEAR PERFORMANCE OF LAMINATED ADHESIVE CONNECTIONS FOR STRUCTURAL GLASS UNDER DIFFERENT GEOMETRIC CONFIGURATIONS

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Abstract: Laminated adhesive connections offer a promising alternative to bolted fittings in structural glass applications, combining transparency with enhanced load distribution and reduced stress concentrations. While previous studies have focused on the effects of temperature and strain rate on these joints, the influence of geometric parameters on their shear performance remains underexplored. This study presents a Finite Element Analysis (FEA) of the shear behaviour of laminated adhesive glass connections with varying adherend shapes (circular vs. square) and geometric configurations. A validated Finite Element (FE) model accurately replicated experimental shear tests for circular Transparent Structural Silicone Adhesive (TSSA) joints. The analysis revealed that circular joints achieved a failure load approximately 9.79% higher than equivalent square joints, owing to their superior stress distribution and reduced corner stress concentrations. Parametric studies further demonstrated that adhesive area (diameter or length) had the most significant impact on shear capacity, while variations in metal thickness, adhesive thickness, glass thickness, and edge distance had more moderate effects. These findings highlight the critical role of geometric optimisation in designing safer and more efficient laminated adhesive joints for structural glass applications.

Keywords: Adherend Shape; Adhesive Area; Finite Element Analysis; Laminated Adhesive; Shear

ICSBE25_192

MODELING EVACUATION CENTER CHOICE BEHAVIOR FOR FLOOD DISASTER: AN MNL APPROACH

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Abstract: Flood disasters in Sri Lanka, particularly in the Rathnapura district, often lead to widespread displacement, compelling residents to seek refuge in designated evacuation centres. The proper functioning of these centres is essential to minimize disaster impacts and to facilitate organized emergency response. However, the growing frequency of floods, coupled with varying capacities and conditions of available evacuation centers, presents challenges for both authorities and flood-affected communities. Understanding the dynamics behind evacuees' decision-making in choosing evacuation centres is crucial for developing effective and people-centered evacuation strategies. This study aims to estimate the factors that influence the choice of evacuation centres during flood emergencies. A Multinomial Logit (MNL) Modelling framework was used to analyse preferences and predict behaviour based on key variables such as distance from home, travel time, centre capacity, accessibility, and available facilities. These facilities include water, electricity, food, sanitation, medical care, sleeping arrangements, the elderly and individuals with disabilities. Data collection was conducted in the Rathnapura district through structured household surveys and secondary sources such as flood maps and evacuation center records. MNL estimations through the utility maximization theory show that relatives' and friends' homes are the most preferred option, followed by religious places and schools, with nearly equal preference. Among all factors, distance and travel time were found to be the most influential, followed by the center capacity. The model outputs further indicates that previous disaster experience and trust in disaster management authorities affect the final choice. The insights derived from this study support the enhancement of disaster preparedness plans, suggesting the need to improve shelter infrastructure, strengthen communication strategies, and build public trust to ensure more effective and timely evacuations in flood-prone areas.

Keywords: Disaster Mitigation; Evacuation Centre Choice; Flood Evacuation; MNL Modelling

ICSBE25_194

EVACUATION ROUTE CHOICE MODELLING FOR FLOOD DISASTERS: A RECURSIVE LOGIT APPROACH

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Abstract: Flood evacuation planning in densely populated areas requires a proper understanding of how people make decisions under emergency conditions, as poor evacuation decisions can lead to significant casualties and economic losses. Traditional evacuation models often have less possibility to capture the dynamic nature of human decision-making during emergencies, particularly in flood-prone regions where conditions change rapidly. Therefore, advanced route choice models are required to provide better evacuation planning processes. The Recursive Logit modelling approach is one of the latest dynamic route choice models that is used to capture the sequential process of decision making with a sequential time discount factor (β). This model has rarely been used for the analysis of flood disasters. Hence, this is a novel approach which is able to capture the decision-making dynamics in emergency scenarios. Methodology integrates primary data from evacuation surveys and GPS tracking, as well as secondary data on traffic flows and flood risk maps in the Rathnapura district. R Studio platform is utilized for model estimation to capture varying decision-making behaviours, with discounted β values reflecting different decision-making behaviours from myopic decisions ($\beta = 0$) to fully forward-looking ($\beta = 1$). By capturing both immediate utilities (travel time, perceived risk) and future expected utilities (scaled by β), the model provides a realistic representation of evacuation behaviour. The approach identifies critical decision points in the network where evacuees face significant trade-offs between short-term convenience and long-term safety, as low β values correlate with myopic choices while high β values reflect risk-averse, safer route selections. The study concludes that the β-Scaled Recursive Logit model estimated a value of 0.46 for β, which significantly indicates the lack of knowledge on proper evacuation routes. The framework enables data-driven decision support systems that can enhance community resilience and reduce evacuation times during flood emergencies.

Keywords: Decision-Making Dynamics, Evacuation Planning, Flood Management, Recursive Logit Model, Route Choice Behaviour

ICSBE25_228

CAN AI CHATBOTS SUPPORT DISASTER AWARENESS AND RISK REDUCTION IN SRI LANKA? A DESIGN-ORIENTED OPINION

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Abstract: Disasters are natural occurrences that result in property destruction and loss of lives. Accurate city location information is essential for conducting rescue efforts before, during, and after disasters; nevertheless, obtaining such information is often exceedingly challenging. Recent technological advancements facilitate the acquisition of essential information from citizens and the dissemination of this information through various disaster management organizations via internet applications. Despite the widespread integration of Artificial Intelligence (AI) technology in disaster response, frameworks for promoting long-term awareness and proactive mitigation, especially in resource-limited areas, are still lacking. This research intends to evaluate the capabilities of AI chatbots in disaster communication in Sri Lanka, specifically regarding floods and landslides, and explores their potential as participatory technology. Through a literature review, analysis of planning frameworks, and two rounds of expert consultations, the study identifies significant gaps, highlighting opportunities for employing chatbots to improve risk awareness, facilitate enhanced decision-making, and foster tailored multi-stakeholder engagement for active participation. This study calls for a responsive, modular, and user-centered design synthesis for the public, planning authorities, developers, and investors, with chatbots integrated across the pre-, during, and post-disaster involvement phases. The paper highlights that a context-sensitive, adaptable, and bi-directional institutional chatbot system addressing local informational requirements can significantly enhance disaster preparedness, urban resilience, and facilitate the attainment of SDG 11 and SDG 13. The proposed method for recontextualizing catastrophe awareness in Sri Lanka and comparable areas is predominantly pragmatic and scalable. By aligning chatbot design with local governance structures, cultural norms, and climate adaptation needs, this paper positions AI chatbots as a viable tool to advance participatory DRR and enhance climate resilience in the Global South.

Keywords: AI Chatbots; Digital Resilience; Disaster Awareness; Disaster Risk Reduction; Participatory Communication; Sri Lanka

ICSBE25_269

PLANNING FOR DOWNSTREAM RIVERBED PROTECTION ACCORDING TO VARYING JET TRAJECTORY OF CHUTE SPILLWAYS WITH FLIP BUCKETS

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Abstract: The hydraulic behaviour of water jet trajectories from chute spillways with flip buckets plays a critical role in ensuring efficient energy dissipation and protecting downstream riverbeds. This study investigates the trajectory characteristics of water jets discharged from a chute spillway with a flip bucket under varying flow rates, using three-dimensional Computational Fluid Dynamics (CFD) analysis. Numerical simulations were performed with ANSYS CFX 17.2 to analyze trajectory profiles, jet velocities, and impact locations on the downstream riverbed for different discharges. The numerical model was calibrated and validated using data from a physical model study. Comparisons between physical model observations and CFD results show good agreement in chute flow velocities, jet trajectory lengths, heights, and impact zones. The results indicate that higher discharges generate jets with greater velocity and momentum, leading to strong streamline convergence, high coherence, and minimal air entrainment. These jets maintain a well-defined trajectory, remaining coherent over approximately 70–80% of their travel distance. In contrast, lower discharges produce weaker, more dispersed jets with increased spatial spreading, which break up earlier and lose coherence within 30–40% of their trajectory at one-fourth of full discharge. Consequently, the stress exerted on the riverbed by jet impact is reduced by about one-fourth. The validated CFD model provides a reliable tool for analyzing the effects of discharge variation in chute spillways with flip buckets. It enables estimation of scouring potential in jet impingement zones and supports planning for targeted riverbed strengthening. This study thus offers a robust framework for simulating flip bucket jet trajectory behaviour and can be extended to similar hydraulic design applications. The CFD tool is valuable both for optimizing flip bucket design to enhance energy dissipation and for improving the design of downstream riverbed protection.

Keywords: CFD; Chute Spillways; Flip Buckets; Jet Trajectory Behaviour; Streambed Protection

ICSBE25_290

EVALUATION OF THE FIRE PERFORMANCE OF LIGHTWEIGHT PREFABRICATED PANELS

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Abstract: Lightweight prefabricated panels are becoming increasingly popular in contemporary construction because of their benefits in terms of sustainability, ease of installation, and cost-effectiveness. But given that many of these panels contain flammable core materials and are challenges to their fire performance. Through experimental investigation of their behaviour under typical fire exposure, this study aims to assess the fire resistance of industrially accessible lightweight prefabricated panels available in Sri Lanka. A calibrated Bunsen burner is being used as a heat source in a small-scale experimental setup. To determine the relationship between the Bunsen burner distance (Burner tip to the fixed measuring point) and the temperature at a fixed measuring point, a preliminary calibration was carried out. The distance from the burner tip to the fixed temperature measuring point was varied. For each distance, the corresponding temperature was recorded. Then, a distance versus temperature plot was created accordingly. In order to maintain standard fire exposure conditions according to standards, panels are fixed at a fixed horizontal distance from the burner tip during testing, and the distance from the burner tip to the exposed surface of the sample is adjusted to control heat intensity. According to the standards, insulation (limiting heat transfer to the unexposed surface) and integrity (preventing passage of flame or hot gases to the unexposed surface) are the main criteria to be evaluated for the fire performance. Cotton pads and gap gauges are used to detect flame penetration and openings to identify integrity failure, while K-type thermocouples are installed on the unexposed surface with a data logger to identify insulation failure. The findings are expected to help identify performance limitations and provide practical recommendations for enhancing the safety of prefabricated panels, with specific recommendations aimed at enhancing fire resistance and overall structural reliability.

Keywords: Fire Curves; Insulation; Integrity; Prefabricated Panels; Thermocouples

ICSBE25_356

INFRASTRUCTURE VULNERABILITY ON BUSINESS PERFORMANCE OF THE SMALL-SCALE DRY FISH PROCESSING ESTABLISHMENTS

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Abstract: Small-scale dry fish processing is an important livelihood activity in coastal communities, ensuring food and nutritional security while offering income and employment opportunities, especially for women. The aim of this study is to assess the vulnerability of the critical infrastructure in small-scale dry fish and Maldive fish processing establishments and to recommend suitable facility improvements to reduce their exposure to environmental threats and enhance overall resilience. The study employed a cluster sampling approach, purposively selecting key fish processing clusters along the South and West coasts. Respondents were purposively selected within these clusters, including 39 from Kudawella, 37 from Ambalangoda, and 52 from Negombo, including both owners and laborers. Data were collected using field observations, focus group discussions, and in-depth interviews. Local knowledge and locally available basic fish drying infrastructure, drying yards, boiling units, wastewater discharge methods, storage and transport methods were highly exposed to climate change-induced hazards. The drying infrastructure of all locations were highly sensitive to climate hazards, mainly heavy rains, flash floods, and unpredictable heavy rains. Climate change adaptation measures along the supply chain for both dry fish and Maldive fish were limited. The assessment reveals that access roads, drying racks, storage methods, and wastewater disposal units were highly vulnerable to heavy rainfall and flash floods. In contrast, limited space for drying, availability of fish, purchase of fresh fish, disposal of waste, and storage were highlighted as highly vulnerable steps of dry fish processing. Drying yards in Negambo were highly vulnerable compared to those in Kudawella and Ambalangoda. Drying on coir mats spread on sandy beaches involves a rapid drying process followed by a post-drying process. Additionally, grading and packing in open beach yards pose extra risks. Unavailability of risk-bearing mechanisms, insurance, and credit added additional pressure on dry fish processors

Keywords: Coastal Communities; Fish Processing Infrastructure; Small-scale Fish Processing; Vulnerability Assessment

ICSBE25_377

THE CASCADING ECONOMIC TOLL OF FLOODS: A RAPID REVIEW OF BUSINESS INTERRUPTION COSTS

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Abstract: The growing frequency and severity of flood events globally have heightened the urgency of understanding their economic impacts. This focus on business interruption is critical for enhancing financial resilience and reducing disaster risks. This study employs a Rapid Review (RR) methodology to synthesize existing literature on this vital subject. The research questions were formulated using the SPIDER framework, and the Rayyan software was utilized to screen articles by title, keywords, abstract, and full text. Twelve articles met the inclusion criteria following a search of the Scopus database using two search strings. The selected publications were analyzed to map the co-occurrence of keywords, year of publication, and geographic focus. The geographic distribution of this preliminary sample, though small, is notably concentrated in flood-prone regions of Europe and Asia. The findings reveal that indirect losses and business interruption costs are severe, often exceeding direct physical damages, especially when critical supply chains are disrupted. Small and Medium-sized Enterprises (SMEs) are identified as particularly vulnerable due to financial constraints, lower preparedness, and a disproportionately high impact on operational continuity. The primary drivers of disruption include damage to factory buildings, production equipment, and interruptions to the power supply. A significant limitation identified in the extant literature is the pervasive lack of granular data. This underscores the critical requirement for field questionnaire surveys in future research to capture location-specific, ground-level data. This gap encourages the exploration of advanced computational models. The study underscores a critical deficit in robust business continuity plans for long-term business recovery. This RR provides an initial snapshot. It demonstrates the necessity for a subsequent systematic literature review. A more comprehensive analysis, using expanded search strings, is essential to thoroughly identify research gaps and formulate a comprehensive agenda for future research.

Keywords: Direct Impacts; Economic Resilience; Indirect Impacts; Qualitative Analysis; Thematic Analysis

ICSBE25_416

MULTI SCENARIO FLOOD RISK MAPPING UNDER CLIMATE CHANGE USING HEC-RAS 2D AND GIS BASED MULTI-CRITERIA DECISION ANALYSIS (MCDA) FOR GIN RIVER BASIN, SRI LANKA

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Abstract: Floods are among the most frequent and destructive natural hazards in Sri Lanka, and their impacts are expected to intensify under changing climatic conditions. The Gin River Basin, located in the southwestern part of the island, has been repeatedly affected by severe floods, resulting in damage to infrastructure, agriculture, and livelihoods. This study presents a multi-scenario flood risk mapping framework that integrates hydrological and hydrodynamic modelling with advanced spatial analysis to assess the impacts of climate change on flood hazards. Future precipitation data from the CNRM-CM6-1-HR Global Climate Model were bias-corrected using the quantile mapping technique and applied under two Shared Socioeconomic Pathways (SSP1 - 2.6 and SSP5 - 8.5) for the period 2030 - 2100. HEC-HMS was used to transform rainfall into runoff, and the resulting hydrographs were applied to HEC-RAS 2D for the simulation of flood extent, depth, and velocity. Model calibration and validation with the May 2003 and May 2017 flood events produced spatial accuracies of 68% and 74% respectively. The hazard outputs were further combined with demographic, land use, and infrastructure data in a GISbased Multi-Criteria Decision Analysis (MCDA) to produce comprehensive flood risk maps. Results demonstrate that the high-emission scenario (SSP5 - 8.5) will lead to substantially increased inundation extents and higher exposure of vulnerable communities compared to SSP1 - 2.6. The study highlights the importance of adopting climate-resilient flood risk management strategies and demonstrates the potential of integrating advanced hydrodynamic models with GIS-based decision support tools to inform spatial planning, disaster preparedness, and long-term adaptation in flood-prone basins of Sri Lanka.

Keywords: Climate Change; Flood Risk Mapping; Gin River Basin; GIS; HEC-RAS 2D; Multi-Criteria Decision Analysis

ICSBE25_436

REUSABLE MODULAR HOSPITALS FOR CLIMATE-DRIVEN DISASTER RESPONSE

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Abstract: The COVID-19 pandemic revealed critical gaps in emergency healthcare infrastructure worldwide. In Sri Lanka, this urgency led to the development of modular, foldable shelter hospital units for rapid deployment. With climate change driving more frequent floods, landslides, and tsunamis, these units can now be positioned as reusable solutions for diverse disaster emergencies where temporary medical facilities are urgently needed. This study focused on converting hospital modular units developed for COVID-19 that are structurally resilient, logistically practical, and culturally appropriate. A mixed approach was adopted, combining design development, structural evaluation, and prototype testing under real-world constraints. Field experience during the pandemic provided insights into transport, storage, and assembly, which were further assessed for application in multi-hazard contexts. Findings confirmed the adaptability of the modular units across different disaster scenarios. The designs demonstrated sufficient strength for reuse, while their foldable, transportable features allow rapid deployment under challenging conditions. The units can also be scaled, combined, and reconfigured to meet varying healthcare demands, making them versatile assets for disaster preparedness. This study highlights the potential of reusable modular hospital units to address both epidemic response and climate-driven disasters. By integrating structural resilience with logistical feasibility, the proposed approach strengthens national preparedness and offers a transferable framework for wider regional adoption. Continued refinement, broader testing, and integration into disaster management systems are recommended to ensure readiness for future emergencies.

Keywords: Climate Change; Disaster Preparedness; Modular Hospitals; Multi-hazard Response; Reusable Infrastructure

ICSBE25_475

AGRICULTURAL DROUGHT ANALYSIS IN KIRINDI OYA RIVER BASIN

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Abstract: Agricultural drought poses a serious threat to food security, livelihoods, and ecosystem health in tropical regions. This study focuses on agricultural drought conditions in the Kirindi Oya River Basin, situated in southeastern Sri Lanka, by separately analyzing the dry, arid, and intermediate climatic zones over the period 1990–2024. The objective is to assess spatial and temporal variability in vegetation response to drought and to understand zone-specific drought dynamics. A multi-index, multi-timescale approach was employed using satellite-based vegetation datasets, including the Normalized Difference Vegetation Index (NDVI) and Vegetation Condition Index (VCI). These indices were evaluated at 1-, 3-, 6-, and 12-month timescales to capture both short and long-term agricultural drought variability. Results reveal pronounced differences in drought severity and persistence among the three zones, with the arid and dry zones exhibiting higher sensitivity to prolonged rainfall deficits compared to the intermediate zone. Correlation analyses demonstrate stronger relationships between indices at longer timescales, underscoring the cumulative effect of persistent dry conditions on vegetation health. The findings emphasize the importance of zone-specific drought monitoring and tailored management strategies. This study provides critical insights for improving early warning systems, optimizing irrigation planning, and promoting sustainable agricultural practices in drought-prone tropical river basins.

Keywords: Agricultural Drought; Kirindi Oya River Basin; NDVI; VCI

ICSBE25_513

A REVIEW OF FLOOD DAMAGE ESTIMATION METHODS FOR COMMERCIAL AND INDUSTRIAL BUILDINGS: INSIGHTS FROM SRI LANKA AND BEYOND

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Abstract: Floods are among the most destructive natural disasters worldwide, causing economic and social impacts every year. Therefore, systematic estimation of flood damage is essential not only for risk assessment and mitigation planning but also for post-disaster recovery. Flood damage of an inundated building can vary considerably according to its use. Existing methods for quantifying direct flood losses to commercial and industrial buildings were examined in this rapid review, focusing on damage to both structure and contents. International and Sri Lankan literature were explored and evaluated, considering their applicability in the Sri Lankan context. According to review findings, structural damage has received considerable attention in prior literature, but contents, often the most variable component in commercial and industrial buildings, remain poorly addressed. Existing methodologies frequently aggregate all non-residential buildings into a single category, ignoring sector-specific and size-specific differences in structure and content characteristics. When developing depth-damage functions, challenges include addressing variability across building types, balancing empirical and synthetic approaches, ensuring transferability of depth-damage functions, and incorporating uncertainty at the micro-scale. By identifying methodological gaps and offering direction for sector-specific approaches, this study contributes to improving flood risk assessment and resilience planning for commercial and industrial sectors in Sri Lanka and similar developing countries.

Keywords: Building Contents; Building Structure; Depth-damage Functions; Loss Estimation; Non-Residential Buildings

ICSBE25_532

A REVIEW ON FLOOD IMPACTS AND THEIR RELATIONSHIP WITH FLOOD MAGNITUDE BASED ON NILWALA RIVER BASIN, SRI LANKA

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Abstract: Floods are one of the most frequent and devastating natural disasters in the world, which cause significant physical, economic, and social disruption. Impacts of floods on communities remain less explored and inadequately addressed in policy making and planning. The study comprises a systematic literature review that examines existing literature on the negative consequences of flood events, with a focus on tangible and intangible flood impacts that impact loss of life, mental health, livelihood disruption, education, and social infrastructure of the communities. Then it examines the relationship between flood magnitude, that is measured as the water level, and the damages caused in terms of the number of people affected, death records, injuries, and damage to houses, considering recently occurred flood events in the Nilwala River Basin of Sri Lanka. The analysis shows strong positive correlations between flood magnitude and the number of people affected, as well as the number of fully and partially damaged houses. The relationships reveal that higher flood levels can cause significantly high levels of damage, particularly in regions with limited capacity to adapt and respond. It also highlights the role of social capital and community resilience in mitigating the impacts that are much needed in the future. The findings reveal the need for more integrated and socially responsive long-term flood risk management strategies and plans to overcome and address human impacts immediately.

Keywords: Community Vulnerability, Intangible Flood Damage, Non-structural Measures

ICSBE25_578

DISASTERS AND ETHNIC MINORITY WOMEN ENTREPRENEURS: A CRITICAL REVIEW

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Abstract: This paper consists with a critical analysis of the impact of the COVID-19 pandemic and the recent economic crisis on Ethnic Minority Women Entrepreneurs (EMWEs) in Sri Lanka. It produces syntheses of international and global scholarship so as to examine the intersection of gendered susceptibility and ethnic susceptibility with the predicaments of disasters in entrepreneurship. Using the Resilience Theory and Intersectionality as the analytical tools, the paper evaluates the limitations of the existing studies critically and specifies the main theoretical, contextual, and methodological gaps. The review suggests a conceptual framework defining the directions of how the two disasters affect adaptive strategies and resilience outcomes of EMWEs. Results show that the available literature was mostly descriptive, under-theorised and biased to Global North settings, thus highlighting the urgency of context-specific models in the Global South. The study will add to the post-crisis recovery and inclusive development agenda of Sri Lanka by incorporating the crisis entrepreneurship perspective, the gender perspective, and the intersectional resilience perspective. The study contributes by integrating crisis entrepreneurship, gender, and intersectional resilience perspectives relevant to Sri Lanka's post-crisis recovery and inclusive development agenda.

Keywords: Ethnic Minority; Twin Disasters; Women Entrepreneurs

ADVANCED CROP PRODUCTION TECHNOLOGIES FOR SUSTAINABLE AGRICULTURE

ICSBE25_030

DEVELOPMENT OF A MULTIFUNCTIONAL SOLAR-POWERED INSECT TRAPPER WITH ANIMAL DETERRENT FEATURES

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Abstract: This project introduces the development of a multifunctional solar-powered insect trapper with integrated animal deterrent features, intended to offer a sustainable alternative to traditional pest control techniques. Chemical pesticides have long dominated agricultural practices, yet their environmental consequences—such as soil degradation, water contamination, and harm to beneficial organisms—demand cleaner alternatives. The proposed system provides a renewable-energy-powered solution that merges intelligent control mechanisms with practical agricultural needs. The design includes a fan-driven insect trap activated by infrared sensors, pheromone-based attractant dispensers, and a storage unit with automated door functionality. Furthermore, ultrasonic sound emitters and high-intensity LED strobe lights, activated by PIR motion sensors, deter animals like birds and rodents without causing ecological harm. The device operates autonomously using solar power managed by a Light-Dependent Resistor (LDR)-based tracking system and regulated through an MPPT charge controller. Central to the design is an Arduino Nano microcontroller that facilitates sensor coordination, remote control functions, and routine maintenance cycles. Comprehensive testing revealed an 85% insect capture efficiency and 90% deterrence success, demonstrating real-world applicability. Its modular design and low-cost components support scalability and widespread adoption, especially in regions lacking grid access. By reducing dependency on chemical agents and embracing smart electronics, this project fosters sustainable agriculture, biodiversity preservation, and food security. The trapper represents a shift towards eco-engineered farming tools, aligned with global sustainability goals. This innovation not only meets immediate pest control needs but also lays the groundwork for future developments in precision agriculture and green technology integration.

Keywords: Animal Deterrent; Eco-friendly Pest Control; Insect Trapping; Renewable Energy; Smart Agriculture; Solar-powered Trapper

ICSBE25_039

SHAPING THE YAMS: A MORPHOLOGICAL JOURNEY THROUGH SELECTED *Dioscorea* ACCESSIONS

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Abstract: *Dioscorea*, commonly known as yam, is a vital food crop in tropical regions, contributing significantly to food security and local economies. By 2024, the Plant Genetic Resource Centre (PGRC) in Sri Lanka has conserved a collection of 215 yam accessions, though several of them require future research and analysis. This study aimed to characterize the morphology of selected yam accessions maintained at PGRC. Twenty-five accessions were evaluated under standardized homogeneous conditions from June to November 2024, during the vegetative growth stage of the vines. Using international yam descriptors, 84 traits were assessed for each accession. Data were analyzed using SAS JMP Pro 18 for cluster analysis and descriptive statistics. Each of the 25 accessions exhibited distinct traits, with no duplications in the selected PGRC collection. Cluster analysis grouped the accessions into three main clusters: Cluster 1 had three accessions of *Dioscorea bulbifera,* namely BTD-6, BTD-67, and BTD-243; Cluster 2 contained six accessions of *Dioscorea esculenta*; and Cluster 3 contained 16 accessions of *Dioscorea alata*. Qualitative traits accounted for 73.2% of the variation, quantitative traits explained 69.6% when the analysis was performed separately and a combination of both qualitative and quantitative traits explained 72.6%, with no change in cluster grouping. Key traits for grouping included stem color, stem wing color, and stem hairiness as qualitative traits, while stem length, leaf size, and number of branches were key quantitative traits. The findings of this study are valuable for systematic germplasm conservation and the utilization of prominent traits in yam varietal improvement programs. Future research should also focus on reproductive and storage traits to enhance the value of these findings.

Keywords: *Dioscorea alata*; *Dioscorea bulbifera; Dioscorea esculenta*; Germplasm Conservation; Morphological Traits

ICSBE25_046

INTEGRATING SOIL AND CROP DIAGNOSTICS WITH NIR SPECTROSCOPY AND MACHINE LEARNING: A SYSTEMATIC REVIEW

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Abstract: The combination of Machine Learning (ML) and Near-Infrared (NIR) spectroscopy is transforming precision agriculture because it has introduced the capability of quickly assessing soil and crop quality in a non-destructive and data-driven manner. This systematic study explores the current developments in the field of NIR-ML applications and their key agricultural applications, which include soil nutrient profiling, pH and electrical conductivity analysis, detection of pesticide residues, organic carbon estimation, crop ripeness readings, disease workups, and seed quality testing. The PRISMA review methodology was utilized to reveal the analysis of 35 peer-reviewed, openly accessed articles (2015-2025) found in databases such as Google Scholar, ResearchGate, and MDPI. In the review, every study has been evaluated according to the pre-processing methods, ML algorithms used, the target applications, and the measures of predictive performance. General conclusions include that ML models, namely Support Vector Machines (SVM), Artificial Neural Networks (ANN), Random Forests (RF), Convolutional Neural Networks (CNN), and Partial Least Squares Regression (PLSR), consistently yield quite good predictive results – R^2 is greater than 0.80 and classification accuracy is greater than 90%. Techniques of pre-processing, such as derivatives, Standard Normal Variate (SNV), Multiplicative Scatter Correction (MSC) and Principal Component Analysis (PCA) were identified to greatly improve the performance of the models greatly. The most notable ones are mapping of soil fertility, early crop stress and disease identification, classification of varieties, and forecasting of yields. In-field, real-time monitoring is also being enhanced by emerging technologies, including portable VIS-NIR sensors, drone-integrated systems, etc. Nonetheless, certain issues remain to be solved, such as the limitation to improve the generalizability of the models to various agro-climatic regions, better feature selection methods, the need to connect with the IoT-based decision-making platform, and the need to improve accessibility among smallholder farmers. The future trends highlight the use of edge computing, autonomous grading systems based on AI, and mobile-based platforms that can define the future of soil and crop quality monitoring, thus benefiting the world through sustainable agriculture.

Keywords: Crop Monitoring; Machine Learning; NIR Spectroscopy; Precision Agriculture; Smart Farming; Soil Quality Analysis

ICSBE25_054

SHADE NET HOUSE VANILLA CULTIVATION AS A CLIMATE ADAPTATION STRATEGY: CONSTRAINTS AND OPPORTUNITIES IN SRI LANKA

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Abstract: This study aims to identify the constraints and opportunities associated with vanilla cultivation methods through assessing shade net house cultivation in the Udapalatha Divisional Secretariat (Kandy District) as a climate adaptation technology for sustainable agriculture. The study was designed as a descriptive research survey and both quantitative and qualitative approaches were used to analyze farmers' perceptions, willingness, and challenges in adopting shade net house farming. Nine Grama Niladhari divisions were selected with high potential for vanilla cultivation. Eighty registered vanilla farmers were purposively selected to ensure relevant insights from experienced cultivators. Results revealed that the protected cultivation method significantly enhances productivity as farmers report substantially higher vanilla yields under shade nets compared to traditional open-field methods. Several constraints and opportunities associated with shade net house vanilla cultivation were identified. Among the key constraints, limited access to initial capital investment was frequently cited, as the cost of constructing shade net structures and installing associated technologies were perceived to be high. Technical knowledge gaps were also observed. Particularly regarding the maintenance of controlled microclimatic conditions and pest management practices within shade net environments. Furthermore, inadequate institutional support and limited access to extension services were also reported. As an opportunity, a growing demand for high-quality vanilla in both domestic and international markets was identified. Overall, it was mentioned that with targeted interventions, financial support schemes, technical training, and strengthened institutional linkages, many of the constraints could be addressed, enabling an increase in the benefits of shade net house cultivation.

Keywords: Agroecological Practices; Crop Diversification; Farmer Empowerment, Microclimate Management; Sustainable Livelihoods

ICSBE25_095

EVALUATING FOUR DIFFERENT POTTING MEDIA MIXTURES FOR TURMERIC (*Curcuma longa* L.) NURSERY PLANT PRODUCTION

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Abstract: Evaluating nursery potting mixtures has become vital since they play a critical role in the growth and development of turmeric during the early stages. This study assessed the effectiveness of four potting mixtures on plant growth. Turmeric seed rhizomes were treated with mancozeb (0.3%) for 30 minutes, cut into single buds (5–10 g), and planted in nursery trays with 60 holes. Each tray was filled with one of five treatment potting media mixtures: T0 (topsoil + cattle manure + coir dust + sand, 1:1:1:1), T1 (topsoil + water hyacinth (WH) compost + coir dust + sand, 1:1:1:1), T2 (topsoil + commercial compost + coir dust + sand, 1:1:1:1), T3 (topsoil + WH compost + sand, 1:1:1), and T4 (topsoil + commercial compost + sand, 1:1:1). These planted trays were kept in a 50% shade net house and watered manually whenever necessary. The experiment was laid out in a Randomized Complete Block Design with three replicates and 15 plants per replicate. Plant height, number of leaves, leaf width, and leaf blade length were recorded at 30 and 60 days after planting (DAP). Further, data on leaf area, shoot fresh and dry weights, and root fresh and dry weights were collected only at 60 DAP. Using SPSS, the data were analysed using a one-way ANOVA and mean separation with Duncan's Multiple Range Test (DMRT). T4 showed the highest values in shoot length (2.34 ± 2.73 mm), number of leaves (0.98 ± 1.21), leaf width (1.20 ± 1.45 mm), and leaf blade length (3.88 ± 4.83 mm). However, some parameters of T4 were not significantly different compared to T1 ($p < 0.05$). T3 also showed favourable results, particularly in promoting leaf development, making it the second-best potting medium. These findings highlight the effectiveness of T4 in providing optimal conditions for turmeric nursery growth, influencing key parameters necessary for plant vigour and productivity.

Keywords: Growth Parameters; Nursery Plants; Potting Media; Turmeric

ICSBE25_101

IMPACT OF BIOFILTER MATERIAL TYPE ON ENHANCING PLANT BIOMASS IN AQUAPONIC SYSTEMS

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Abstract: Aquaponics is a sustainable farming system that combines aquaculture and hydroponics, utilizing nitrifying bacteria to convert toxic fish waste into nutrients that can be absorbed by plants. The biofilter media is an integral part of system performance, as it allows bacteria to have a surface area for growing. When fish waste is introduced into an aquaponics system with beneficial bacteria, such as Nitrosomonas and Nitrobacter, toxic ammonium is converted into nutrients like nitrite and nitrate. This study aims to determine how effective both synthetic (Rubber and Nylon) and organic (Clay tiles, Gravel, Wood shavings, biochar (charcoal)) waste-derived media are as biofilters in an aquaponic system utilizing black tilapia (*Oreochromis niloticus*) and GIFT (*Oreochromis spp*.). Water spinach (*Ipomoea aquatica*) was grown in a system composed of six biofilters in a two-month-long experiment in which plant wet weight gains were measured. A one-way ANOVA indicated that there were significant differences in plant weight gain by treatment ($P = 0.010$). Gravel, biochar, and shredded rubber had the most densely accumulated biomass, and wood shavings had the least. This study adds to sustainable aquaponic practices by also identifying other cheap local materials that may provide desirable microbial support and may also promote plant growth. Future studies to examine microbial population dynamics on these forms of media may add to our understanding of their performance in a system.

Keywords: Aquaponics; Bacteria; Biofilter; Fabric Material; Sustainability; Tilapia; Water spinach

ICSBE25_120

PRELIMINARY INVESTIGATION TO DEVELOP A FRAMEWORK FOR SUSTAINABLE AGRICULTURE AND INFRASTRUCTURE MANAGEMENT: OPTIMIZING CROP AND LAND USAGE

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Abstract: The physical properties of soil are fundamental in determining crop suitability and agricultural productivity. With the growing emphasis on sustainable agriculture, the evaluation and classification of soil and land suitability have become increasingly critical for informed decision-making. As an initial step toward developing an integrated framework for sustainable agriculture and infrastructure, this study explores soil–crop relationships to optimize land use for improved yields and resource conservation. Effective land utilization for crop maximization represents a key milestone in establishing such a framework. Accordingly, crop selection was guided by major soil properties: texture, pH, nutrient composition, and their correlations with climatic variables and crop types. A comprehensive dataset encompassing plant nutrient requirements, growth parameters, seasonal variations, and geographical conditions was compiled to support this analysis. To facilitate rapid and accessible soil assessment, a Convolutional Neural Network (CNN) model was developed to classify soil types from images. The model achieved a high classification accuracy of 99%, revealing strong correlations between soil types and environmental conditions (e.g., clay soil with rainfall, sandy soil with temperature). This approach supports sustainable agriculture by reducing dependence on extensive laboratory soil testing and promoting data-driven decision-making for farmers.

Keywords: CNN; Land-use Requirements; Machine Learning; Soil Classification; Soil/Land Suitability Evaluation; Sustainable Agriculture

ICSBE25_169

EVALUATION OF RESPONSE TO DIFFERENT COMPOUND FERTILIZERS FOR IMPROVING NITROGEN USE EFFICIENCY BY GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus L.*) IN THE DRY ZONE OF SRI LANKA

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Abstract: Efficient nutrient management is a critical aspect of sustainable vegetable cultivation in Sri Lanka. The Department of Agriculture (DOA) recommends the use of urea, triple superphosphate (TSP), and muriate of potash (MOP) as primary fertilizers. The higher application rates required to meet crop nutrient demands lead to environmental concerns due to nutrient losses and low Nitrogen Use Efficiency (NUE). Compound fertilizers, which provide balanced nutrients, are effective in enhancing Fertilizer Use Efficiency (FUE). This study was conducted at CIC Seeds Farm, Thalawa, in the 2024/25 *Maha* season to evaluate the NUE of six commercially available compound fertilizers using the hybrid Okra variety named “Seetha”. Eight treatments, including T1 (NPK DOA Recommendation), [Compound used efficiency 60% of Nitrogen compared to DOA, T2 (NPK 21-8-11), T3 (NPK 21-7-14), T4 (NPK 12-12-17), T5 (NPK 12-11-18), T6 (NPK 15-5-21), T7 (NPK 15-9-20)] and T8 (No fertilizer) were tested in a randomized complete block design. Plant height as a growth parameter and yield data were recorded. The highest plant height was recorded in T1 (40.62 cm), which was treated with 100% DOA recommendation, followed by T3 (40.12 cm), which was treated with compound fertilizer. T4, T6 and T7 exhibit no significant difference. T8 showed significantly low plant height, which was treated with no fertilizer. The highest yield was recorded in T3, followed by T7, with no significant difference, which were treated with compound fertilizer. T3 and T7 have recorded 27.4 % and 22.1 % yield increment, respectively, compared to T1 (100 % DOA recommendation). Significantly lowest yield was recorded in T8, which was treated with no fertilizer. T2, T5 and T6 have exhibited no significant difference with T1 (100% DOA recommendation). Therefore, findings suggest that the tested compound fertilizers have a similar effect for plant height compared with the 100% DOA recommendation and potential to reduce the recommended use of nitrogen by 40% while sustaining okra yield and enhancing NUE in the dry zone of Sri Lanka.

Keywords: Compound Fertilizers; Fertilizer Use Efficiency; Nitrogen Use Efficiency; Nitrogen; Okra

ICSBE25_173

OPTIMIZING COCONUT ANTHER CULTURE CALLOGENESIS AND CYTOLOGICAL ASSESSMENT OF MICROSPORE MATURITY GRADIENT ALONG COCONUT RACHILLA

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Abstract: Coconut (*Cocos nucifera L.*) plays a vital role in uplifting the national economy; thus invention of high-yielding, superior hybrid varieties is imperative. Conventional propagation of new coconut varieties is highly challenging and requires over 60 years because of the palms' biological constraints. Generation of doubled haploids through androgenesis is a better approach to address these problems. A successful protocol for coconut anther culture was initiated in 2008, obtaining anthers from 3 weeks before splitting (3 WBS) stage inflorescence, which corresponds to the late uni-nucleate stage microspores. In the basal media, 100 µM 2,4-D concentration was used to induce androgenesis but varying 2,4-D concentrations may lead to more effective callus or embryo formation according to the literature. Parallelly, the presence of the required microspore developmental stage in cultured anthers is also crucial for the success rate. In this study, the androgenic response to four varying 2,4-D concentrations was tested with 3 WBS anthers cultured on modified Eeuwen's Y3 media and a histological study was conducted to identify the maturity gradient of microspores existing in the middle rachillae of 3 WBS inflorescences. The experiment was done as a completely randomized design with 10 replicates per each treatment. After 3 months of culturing, swelling rates of placed anthers were statistically analysed using R-studio. The highest potential for androgenesis induction was observed at 100 µM (35.70 ± 1.27) and 150 µM (34.30 ± 0.79) concentrations, while the lowest response was recorded with 50 µM (15.70 ± 0.98). The histological study was conducted by obtaining 3 random middle rachillae from 3 different 3 WBS inflorescences in a tall coconut variety. This study revealed that there is a maturity gradient from top to bottom of each middle rachilla and only the top flowers contain microspores at the late uni-nucleate stage, revealing that it would be better if anthers are obtained from most top flowers for successful results in coconut anther culture.

Keywords: Anther Culture; Callus; *Cocos nucifera L.*; Histology; Male Flower Maturity

ICSBE25_202

DEVELOPMENT OF PLASMA NITROGEN-ENRICHED ORGANIC FERTILIZER FROM REFUSE TEA AND FIREWOOD ASH

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Abstract: The increasing cost and environmental impact of chemical fertilisers have accelerated the search for sustainable alternatives derived from agro waste. In Sri Lanka's tea industry, significant quantities of tea waste or refuse tea and firewood ash are generated as by-products without effective reuse. Although these materials contain essential nutrients, their low nitrogen content limits their direct application as fertilisers. This study aimed to develop a novel organic fertiliser by enriching refuse tea with nitrogen through plasma treatment and combining it with firewood ash to balance its pH and nutrient profile. Refuse tea samples were treated with plasma under a pressure of 140 kg/cm^2 and a gas flow rate of 2 L/min, with time intervals of 5 to 40 minutes. Eight samples were enriched and subsequently mixed with firewood ash. Nutrient analyses, including NPK and pH measurements, were conducted to assess the fertiliser's agronomic suitability. The optimal enrichment was achieved at a treatment time of 30 minutes, resulting in a 24.27 ppm nitrogen concentration with a pH of 2.33 in 10 mL of extract. Mixing 5 g of this enriched refuse tea with 0.27 g of firewood ash yielded a neutral pH. A soil incubation test was conducted using Mung bean seeds to determine the effectiveness of the fertilizer, where the seeds demonstrated improved germination and vigor index. These results highlight the potential of this economical and eco-friendly fertilizer as a sustainable alternative for organic agriculture, while addressing agro-waste management challenges in the tea industry.

Keywords: Agro-waste Management; Firewood Ash; Plasma-nitrogen Enrichment; Refused Tea; Sustainable Fertilizer

ICSBE25_252

THE IMPACT OF INNOVATION ON ORGANIZATIONAL PERFORMANCE IN THE SRI LANKAN TEA INDUSTRY: A COMPARATIVE STUDY OF PRIVATE AND STATE-OWNED PLANTATIONS

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Abstract: In the Sri Lankan tea industry, innovation is increasingly recognized as vital for sustaining competitive organizational performance. However, the sector's performance and global market share have declined in the past decade, partly due to limited adoption of new technologies and value-added processes. This study examines the impact of different types of innovation (product, process, organizational, and marketing) on plantation performance, comparing privately managed Regional Plantation Companies (RPCs) with state-owned plantations. A comparative mixed-methods approach was implemented, featuring surveys of 100 managerial and operational members of the staff across four plantations and qualitative interviews. Quantitative analysis was applied to assess the impact of the innovation initiatives on the productivity, profitability, efficiency measures and the thematic analysis of interviews and focus groups was used as an additional source of information about the practices and the barriers to innovation in each sector. The study indicated that innovation adoption has a positive impact on the key performance indicators and the adoption and performance results of innovation tend to be better in the case of private animal plantations as compared to the state-owned plantations. The study reveals that these differences are determined by the factors organizational culture, accessible resource and flexibility of the organization's structure. The study pointed out both financial constraints and risk aversion as general inhibitors to innovation and, in addition, identifies other impediments in the state sector, including bureaucratic obstacles and reduced managerial freedom. The results indicated that Sri Lanka needs to come up with specific initiatives in order to achieve innovation-led growth and policy intervention to reduce the innovation gap in the tea industry in Sri Lanka.

Keywords: Innovation; Organizational Performance; Private Plantations; Sri Lanka; State-owned Plantations; Tea Industry

ICSBE25_314

TEMPERATURE EFFECTS ON POLLEN GERMINATION IN CASHEW (*Anacardium occidentale* L.) VARIETIES IN SRI LANKA

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Abstract: Development and adoption of climate-resilient crop varieties are essential for promoting sustainable agriculture. These varieties often utilize input resources more efficiently while enhancing the resilience of agricultural ecosystems. Cashew (*Anacardium occidentale L.*) is a high-value nut crop grown in Sri Lanka, where recent yield declines have been largely attributed to insufficient pollination caused by adverse temperature conditions. Despite the vital role of pollination in determining yield, limited data exist on the influence of temperature on pollen germination in local cashew varieties. Therefore, this study aimed to evaluate the effects of varying temperatures on pollen germinability across selected cashew varieties while optimizing in vitro conditions for improved pollen germination. Six different germination media varying in sucrose and Polyethylene Glycol (PEG) concentrations, along with Calcium (Ca), Boron (B), and Magnesium (Mg) levels, were tested to identify the most effective medium. Fresh pollen grains were collected at four time intervals (10:00 a.m., 11:00 a.m., 12:00 noon and 1:00 p.m.) and germination percentage was assessed at four incubation durations (2, 4, 6 and 24 hours) in each medium. Subsequently, pollen grains from six cashew varieties (WUCC 09, WUCC 19, WUCC 21, WUCC 13, WUCC 16, and WUCC 23) collected from the Kammandaluwa and Eluwankulama in Sri Lanka were subjected to four temperatures (28 °C, 32 °C, 36 °C, and 40 °C) to assess germination rates. The highest pollen germination percentage was achieved in the medium containing 20% sucrose, 30% PEG, 40 ppm Ca, 20 ppm B, and 20 ppm Mg, when pollen grains were collected at 10:00 a.m. and incubated for 2-4 hours. Germination rates declined significantly at both lower and higher temperature extremes, with optimal germination observed between 32 °C and 36 °C. Among the tested varieties, WUCC 16 and WUCC 13 exhibited consistently high and stable germination across temperature ranges. These findings provide valuable initiatives for selecting climate-resilient varieties, supporting sustainable cashew production in Sri Lanka under changing climatic conditions.

Keywords: Cashew; Climate-resilient Varieties; Pollen Germination; Temperature

ICSBE25_332

DETERMINATION OF SUITABLE N AND K RATES FOR THE CULTIVATION OF HYBRID OKRA UNDER GREENHOUSE CONDITIONS

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Abstract: Okra (*Abelmoschus esculentus L. Moench*) is a member of the Malvaceae family and an annually cultivated vegetable crop in Sri Lanka. Hybrid okra varieties are being grown popularly because of their higher yield potential, improved fruit quality and resistance to Yellow Vein Mosaic Virus (YVMV). However, fertilizer recommendations for hybrid okra varieties have not been developed by the Horticultural Crop Research and Development Institute (HORDI), Sri Lanka. The present study was conducted to investigate the impact of different Nitrogen (N) and Potassium (K) fertilizer rates on growth and yield parameters of hybrid okra under controlled greenhouse conditions. The hybrid okra variety, AGK-Okra-HY 02, was used and the experiment comprised 12 treatment combinations of N and K levels with four replicates each, resulting in a total of 48 pots. The experimental design follows a Completely Randomized Design (CRD). The results indicated significant effects of N on growth and yield parameters, of stem circumference (1.71 ± 0.14 cm), height (61.50 ± 4.43 cm) root dry weight (0.998 ± 0.056 g), shoot dry weight (7 ± 0.7 g), pod fresh weight (11.46 ± 1.04 g), and pod length (9.45 ± 0.58 cm) with N3 (170 kg/ha) consistently performed the best across these parameters ($P < 0.05$). According to the results, adding high N (N3: 170 kg/ha) significantly improved the growth and yield of AGK-Okra-HY 02. Potassium varying levels (K0: 0 kg/ha, K1:80 kg/ha, or K2:16 kg/ha) did not significantly impact the performance under the conditions tested. These results indicate that optimizing the supply of N is critical for maximizing productivity in hybrid okra. According to this study, N3 (170 kg/ha) optimal rate for Hybrid okra. Whereas, additional K beyond the baseline requirement of 75 kg/ha may not provide the yield advantages sought at the controlled conditions and it is suggested to investigate the impact of higher potassium levels on the growth and yield of hybrid Okra.

Keywords: AGK-Okra-HY 02; Fertilizer Optimization; Nutrient Management; Potential Yield; Productivity

ICSBE25_345

SUSTAINABLE MECHANISATION OF SMALL-SCALE PADDY HARVESTING THROUGH WEIGHT-OPTIMISED NON-DESTRUCTIVE GRAIN SEPARATION TECHNOLOGY

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Abstract: Paddy harvesting remains a labour-intensive and challenging task for small-scale farmers, particularly under wet or muddy field conditions. Traditional harvesting machines, which typically weigh around three tons, often face difficulties operating in such environments, leading to delays, grain losses, and increased operational costs. The researched mechanism, which detaches only the grains while leaving the straw in the field, demonstrates strong potential for developing a lightweight, scaled-down system that avoids sinking or getting stuck in muddy conditions. An energy-efficient mechanism was developed to reduce the number of operations and maintenance requirements while offering greater capacity and lower power consumption compared to conventional combine harvesters. The research objectives were achieved by developing three alternative seed separation mechanisms: a slapping-based mechanism, a dual-roller threshing mechanism, and a rotating tooth-comb mechanism. These designs were fabricated as prototypes and evaluated based on key performance criteria, including operational efficiency, cost, versatility, durability, and design complexity. Based on a comprehensive performance comparison, the rotating tooth-comb mechanism demonstrated superior performance, offering high operational efficiency, low weight, enhanced durability, versatility, and reduced cost. The final developed rotating tooth-comb mechanism consists of a rotor, rotor tooth blades, a grain storage tank, covers, and a separator. The prototype achieved a total weight of approximately 600 kg, the lowest grain damage rate (1–3%), the highest energy efficiency (0.89), acceptable economic parameters (3.1-year ROI), and excellent field adaptability. The results indicate that the rotating tooth-comb mechanism significantly reduces energy consumption and provides an economically viable solution for small-scale farmers. The mechanism offers a sustainable and affordable alternative to modern combine harvesters, thereby enhancing agricultural productivity and improving the livelihoods of smallholder farmers.

Keywords: Grain Separation; Lightweight Harvesting Mechanism; Paddy Harvesting; Rotating Teeth Comb Mechanism; Small-Scale Farming; Sustainable Mechanization

ICSBE25_369

STUDY ON PATTERNS AND REASONS FOR ABSENTEEISM AMONG REGISTERED TEA ESTATE WORKERS: A CASE FROM BADULLA DISTRICT

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Abstract: Absenteeism is a persistent challenge in Sri Lanka's estate sector, undermining productivity, efficiency, and sustainability. This study investigates the patterns and reasons of absenteeism among registered workers at Aislaby Tea Estate in the Badulla District, an estate managed by Malwatte Valley Plantations PLC. A quantitative, cross-sectional survey design was employed, with proportionate stratified random sampling used to select 132 respondents from six estate divisions. Primary data were collected through a structured, pretested questionnaire supplemented by focus group discussions, while secondary data were obtained from estate attendance records, annual reports, and divisional diaries. Data analysis was carried out using descriptive statistical techniques in SPSS. The findings revealed a distinct seasonal pattern of absenteeism, with increased rates during the low-yielding months of September to November, and decreased rates of absenteeism during the cropping months from December to February. Socio-demographic factors such as age, gender, marital status, and family size influenced absenteeism patterns, while health-related factors, including seasonal illnesses, frequent personal health problems, and overall health conditions, were identified as significant contributors. Economic factors were also critical, with workers preferring that small weekly incentives, higher wages, and better economic opportunities could reduce absenteeism, whereas low wages and alternative job options outside the estate increased absentee behaviour. The study concludes that absenteeism is a multi-dimensional issue shaped by personal, social, health, and economic reasons. Addressing absenteeism requires a comprehensive approach that includes improved welfare facilities, targeted health support, and incentive-based economic strategies. The findings provide practical insights for estate management and policymakers in designing interventions to reduce absenteeism, improve workforce stability, and enhance the long-term competitiveness of Sri Lanka's tea industry.

Keywords: Absenteeism; Economic Factors; Health Issues; Labour Productivity; Tea Estate Workers

ICSBE25_407

SOLAR PV POWERED MICRO IRRIGATION SYSTEMS FOR SRI LANKA -A CASE STUDY

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Abstract: The growing population and scarcity of conventional resources highlight the requirement for the utilization of water and energy management in the field of agriculture. As a sustainable energy source, solar-powered micro irrigation systems offer an optimistic solution for rural areas with limited access to non-renewable energy sources. This study evaluates the feasibility of implementing solar PV-powered drip and sprinkler micro irrigation systems in Sri Lanka, and a case study was conducted on a farm in Matale, located in the Central Province of Sri Lanka, to assess the techno-economic viability of the selected systems. The research was done by comprehensive data collection from 2021 to 2022, including solar irradiance levels, pump performance metrics, crop yield data, and economic returns. Results revealed that the drip irrigation system delivered a 52.82% growth in onion yields compared to the sprinkler system. Economic analysis of amalgamated systems showed strong financial feasibility with a Net Present Value (NPV) of $15,391.71 and a payback period of 3.5 years when subsidized. The drip system alone had an NPV of $9,969.21 and a shorter payback period of 3.08 years. Solar pumping achieved 85% reliability, meeting irrigation needs on most days, with a Levelized Cost of Energy (LCOE) of $0.21/kWh, significantly lower than $0.47/kWh of kerosene pumps. This research highlights the long-term benefits, acceleration of crop productivity and energy sustainability of solar PV-powered drip systems and the importance of government subsidies in the Sri Lankan context.

Keywords: Micro Irrigation; PV Powered Micro Irrigation; Solar PV Powered Water Pumping; Sustainable Solar Irrigation

ICSBE25_518

CURRENT PRACTICES, CHALLENGES, AND PROSPECTS IN HYDROPONIC FARMING IN THE WESTERN PROVINCE OF SRI LANKA

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Abstract: Hydroponic farming represents a promising agricultural technology for addressing food security challenges in developing countries, yet adoption patterns and technical challenges remain poorly understood in Sri Lankan contexts. This study investigates the current state of hydroponic farming practices, growing media challenges, and innovation adoption potential in Western Province, Sri Lanka. A cross-sectional survey was conducted among 50 hydroponic farmers across three districts (Kalutara, Colombo, Gampaha in Western Province, Sri Lanka. Data were collected on demographic characteristics, farming experience, crop selection, growing media usage, quality control practices, fertilizer management, and technology adoption willingness. Statistical analyses included descriptive statistics and chi-square test analysis. Findings revealed that hydroponic farming is in its early diffusion stage, with 68% of farmers having less than one year of experience. Males constituted 60% of the sample, though no significant gender–district association was observed. Infrastructure analysis showed that 48% of farmers operated with 2000 ft² polytunnels, and farming experience positively correlated with larger facility sizes ($r = 0.358$, $p = 0.011$). Coir was universally used as a growing medium, while alternative substrates such as compost and chicken manure were adopted by some farmers, despite posing microbial contamination risks. Compost use showed a significant association with increased plant disease incidence ($p = 0.048$). Regarding media reusability, 64% of farmers reused substrates twice, 28% once, and 8% three times, reflecting economic pressures and technical challenges. Crop selection patterns indicated *Capsicum frutescens L*. (Chili Pepper), (54%) and *Cucumis sativus L*. (Cucumber) (42%) as the dominant vegetables, with experience significantly influencing cucumber cultivation ($p = 0.028$). Technical practices showed that 66% monitored pH, while only 44% checked electrical conductivity, though both were independent of workshop participation. Importantly, 94.7% of farmers expressed willingness to adopt a profitable, durable growing medium. The study concludes that while hydroponics is gaining momentum in the Western Province, sustainability is hindered by limited experience, infrastructure constraints, inappropriate use of non-hydroponic media, and inconsistent technical practices. Strengthened training, improved access to appropriate substrates, and innovation in reusable growing media are critical for ensuring safe, cost-effective, and sustainable hydroponic farming in Sri Lanka.

Keywords: Agricultural Extension; Growing Media; Hydroponic Farming; Innovation Willingness; Sustainable Agriculture; Technology Adoption

ICSBE25_534

SOIL NUTRIENT CHANGES IN DIFFERENT CROPPING STAGES OF PADDY CULTIVATION IN DRY ZONE SRI LANKA – A CASE STUDY AT ANURADHAPURA

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Abstract: Nutrient behaviours of soils are a crucial part of paddy cultivation. The crop stage and depth-wise fluctuations were not well known and researched in the dry zone of Sri Lanka. Therefore, this study was conducted to assess (I) the soil nutrient content (N, P) at the depth ranges of 0-15 cm and 15-30 cm during different cropping stages, (II) the relationship between fertilizer application practices and changes in soil nutrient levels at different depths during the cropping cycle and (III) To develop nutrient - spatial variation maps for supporting decisions at fertilizer application and irrigation along with weather parameter relationships. Changes in soil pH, Electrical Conductivity (EC), phosphorus (PO_4^{3-}), and nitrogen (NO_3^-) across stages of pre-tillage, young plant stage, maturity, and post-harvest with soil depths (0-15 cm and 15-30 cm) of paddy land in the Nachchaduwa cascade system. Soil samples were analyzed at pH, EC of 1:5 soil water suspensions, P (PO_4^{3-}) analyzed by ascorbic acid colorimetric method with sodium bicarbonate extraction, and available nitrogen by 2 M KCl extraction followed by UV visible spectrophotometry. Results indicated notable variations in soil pH, EC, nitrate and phosphate across different growth stages and soil depth. At each stage, pH varied between 5.8 - 9.0 in the top soil with peak alkalinity during the maturity stage, whereas pH in the subsoil ranged between 6.4 – 8.17. EC has risen in the reproductive stage, with EC increasing to 140-230 µS/cm after fertilization in localized areas. Topsoil P (PO_4^{3-}) was highest in the post-fertilization phase at up to 8.34 ± 0.7 mg/kg after TSP application, although the topsoil did not show a steady rise in other phases (4.35-6.00 mg/kg). Topsoil available nitrogen peaked at 44.9 ± 4.4 mg/kg in Stage 2 (post-fertilization) compared with more uniformly lower concentrations in the subsoil over all stages. The spatial maps (GIS) confirmed the heterogeneity of nutrient distribution across the field, and very pronounced distinct patterns at individual stages. These results indicate that surface spread fertilizers have minimal impact to a few centimeters of soil in intense spatial and temporal fluctuations. Site-specific nutrient management is shown to be necessary for achieving better fertilizer use efficiency in environmentally sustainable rice farming. It is also demonstrated that blanket fertilizer applications cannot be used effectively in the dry zone of Sri Lanka due to increased environmental risks.

Keywords: Cropping Stages; Dry Zone Agriculture; Paddy Cultivation; Soil Nutrient Dynamics; Sub Soil; Top Soil

WASTE MANAGEMENT AND CIRCULAR ECONOMY

ICSBE25_014

IDENTIFICATION OF A SUITABLE ALTERNATIVE SITE FOR WASTE MANAGEMENT IN KANDY, SRI LANKA USING GIS-BASED MULTI-CRITERIA DECISION ANALYSIS

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Abstract: Gohagoda has been a notable primary waste disposal site for Kandy since the 1950s, receiving approximately 130 tons of waste daily. Due to the improper waste management at Gohagoda for over six decades, there are significant environmental and social issues. Sustainable waste management practices, including waste segregation, recycling, composting, and intermediate treatment, were introduced at this site after 2014. Prior to these improvements, the landfill was recorded to have contributed heavily to pollution, particularly through leachate infiltration and runoff into the nearby Mahaweli River. This posed severe risks to ecosystems and public health. Due to the presented constraints, this study aims to utilize Geographic Information Science (GIS) and Multi-Criteria Decision Analysis (MCDA) to identify an alternative and more appropriate location for waste disposal. Both primary and secondary data collection were conducted. Spatial data was gathered on land use, elevation (DEM), hydrology, developed lands, road network, and major building distribution. The study area was identified using literary sources, while Landsat 8 images and OSM data aided land use classification and road network identification. Weighting criteria were identified based on the Central Environment Authority Guidelines for the Management of Scheduled Waste in Sri Lanka in Accordance with the National Environmental (Protection and Quality) Regulation. Additionally, interviews were conducted with field professionals and residents to identify social factors as criteria for buffer determination. Finally, the weighted overlay model was run to identify potential sites in the Pathahewaheta DS division. After analysis, considerations such as accessibility, regions of development, presence of restricted areas, and expandability were taken into account when determining suitability. Based on this, Uduwela Udagama West, Unuvinna East, Oluwatte, Bawlanwatta Janapadaya, Sriyagama, and Ethulugama South were identified as most suitable for waste management facility development. These areas were selected due to their alignment with environmental safeguards, operational feasibility, and minimal risk factors.

Keywords: Geographic Information Science; Kandy; Multi-Criteria Decision Analysis; Sustainable Development; Waste Management

ICSBE25_118

A GIS-BASED DECISION-MAKING TOOL FOR SUSTAINABLE ORGANIC WASTE MANAGEMENT IN MID-SIZED CANADIAN MUNICIPALITIES TOWARD NET ZERO EMISSIONS

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Abstract: Geographic Information System (GIS)-based decision aid systems play a vital role in supporting sustainable urban planning by enabling spatially informed, data-driven decision-making. This research aims to develop a GIS-based planning tool for optimizing Organic Waste (OW) management in mid-sized Canadian municipalities. The tool is designed to assist municipalities in selecting the most effective and sustainable strategies by integrating three key components: (1) a waste collection option analysis module, (2) a waste treatment option analysis module, and (3) a strategy optimization module that recommends the best-performing OW management pathway along with associated costs. The tool will also incorporate forecasting capabilities to evaluate future scenarios, taking into account changes in waste generation, population growth, and advancements in technology. By providing localized, life–cycle–based evaluations of Greenhouse Gas (GHG) emissions and operational efficiency, the decision-making tool will empower municipalities to adopt sustainable, low-carbon OW management solutions tailored to their geographic and infrastructural contexts. The outcomes of this research will contribute meaningfully to Canada's Federal Sustainable Development Strategy and support progress toward key United Nations Sustainable Development Goals (UNSDGs), particularly those related to climate action, sustainable cities, and responsible consumption and production.

Keywords: Carbon Footprint; GIS-based Decision Making Tool; Net Zero Emissions; Organic Waste Management

ICSBE25_136

LACTIC ACID PRODUCTION FROM COCONUT FIBRE

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Abstract: Lactic acid is a commercially significant organic acid that has attracted considerable attention owing to its extensive applications in food processing, biomedical industries, cosmetic formulations, and pharmaceuticals. It is also used as a raw material for polylactic acid, a biodegradable polymer used in bioplastics. Traditionally, lactic acid is produced from sugar–based feedstocks, which are associated with high costs, food competition, and environmental concerns. As a sustainable alternative, this study investigates the use of lignocellulosic agro–industrial waste, especially coconut husks, for lactic acid production. The research focuses on enhancing lactic acid yield through optimization of pretreatment parameters, especially sodium hydroxide concentration of 0.5 mol/ dm^3, 1.5 mol/ dm^3, and 2.5 mol/ dm^3, together with coconut fiber thickness of 0.25 - 0.5 mm and 0.5 – 2 mm. Alkali pretreatment was employed to reduce the lignin content of the fiber, followed by chemical hydrolysis and microbial fermentation using Lactobacillus species. The presence of extracted lactic acid was confirmed by using Fourier Transform Infrared Spectroscopy. The results indicate that the highest lactic acid yield of 9.08% was achieved under the optimized conditions of 1.5 M sodium hydroxide concentration and fiber thickness of 0.25 – 0.5 mm. This study highlights a promising, cost–effective, and environmentally friendly approach for lactic acid production, contributing to the development of sustainable and bio–based industrial processes

Keywords: Acid Hydrolysis; Alkali Pre-treatment; Fourier Transform Infrared Spectroscopy; Lactic Acid; *Lactobacillus* species; Microbial Fermentation

ICSBE25_145

BANANA PEELS AS A SUPERIOR BIO-ABSORBENT FOR SOLAR CELLS: A COMPARATIVE REVIEW OF FRUIT PEEL-DERIVED MATERIALS

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Abstract: The increasing global demand for clean energy has driven significant interest in utilizing biowaste-derived materials in photovoltaic technologies. This review evaluates the suitability of selected fruit peels, namely banana, orange, and pineapple peels, as low-cost and sustainable absorbent materials for solar cell applications. The analysis focuses on their photonic properties, carbon content, surface morphology, and availability. Banana peels, due to their high concentrations of polyphenols, lignin, and carbon-rich precursors, demonstrate superior light absorption and carbonization potential, making them favourable for conversion into functional materials such as carbon quantum dots and biochar. Specifically, banana peel-derived materials show high UV-Vis absorption, often in the 250-550 nm range, with CQD Photoluminescence Quantum Yields (PLQY) reported between 8–12%. Orange and pineapple peels also contain valuable bioactive compounds; however, their relatively lower absorbance capacity and reduced structural integrity after thermal processing may limit their effectiveness in solar cell applications. The comparative assessment highlights the potential of banana peels as a high-performance and scalable bio-absorbent, contributing to the development of greener and more efficient solar energy technologies through effective waste valorization.

Keywords: Absorbance; Biowaste; Natural Pigments; Solar Photovoltaic; Waste Valorization

ICSBE25_148

IMPACT OF MATERIAL WASTAGE ON CONSTRUCTION PROJECT COST

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Abstract: This study examines the impact of material wastage on construction project costs, with a focus on Sri Lanka's building construction sector. It identifies the main causes of material wastage, categorizing them into design and documentation, procurement, construction practices, material handling, storage, transportation, environmental and external conditions, and operational factors. A survey was conducted among construction professionals, and the data were analyzed using the Relative Importance Index (RII). The study revealed that materials such as concrete, reinforcement/steel, formwork/timber/wood, bricks/blocks, mortar, sand, aggregates/stone, ceramic tiles, cement and pipes/wires are the most dominant in material wastage. Further, it highlighted that the material wastage directly leads to cost overrun, ranging between 2.2% and 5.63% of the total project cost for selected materials. Among these, sand had the highest wastage rate, at 9.07%. The findings emphasize the necessity for targeted strategies to reduce wastage, such as improving procurement processes, implementing better storage practices, and enhancing worker training. The research highlights the need for further studies to validate wastage percentages using actual project data and explore the link between material wastage and broader economic impacts. This study serves as a resource for contractors and policymakers, offering insights to improve efficiency. Not only that, it can help to reduce environmental impact and enhance sustainability in the construction industry. By addressing material wastage, stakeholders can optimize resource utilization and contribute to economic and environmental goals. The findings underline the importance of waste management policies tailored to the unique challenges of the construction sector.

Keywords: Causes of Waste; Construction Waste; Cost Overrun; Material Wastage Percentage; Material Wastage

ICSBE25_168

VALORIZATION OF FRUIT AND VEGETABLE WASTES AS BIOPOLYMERS: A SUSTAINABLE APPROACH FOR FOOD PACKAGING APPLICATIONS

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Abstract: Globally, approximately one-third of food produced for human consumption is lost or wasted annually, amounting to 1.3 billion tons. Fruit and vegetable waste accounts for over 42% of total food waste, presenting significant environmental, economic, and social challenges. Fruit and vegetable wastes exhibit particularly high wastage percentages (40 - 50%) due to their perishable nature and rapid biodegradability. These wastes are rich in natural biodegradable polymers, containing 70-90% carbohydrates and 9% cellulose by dry mass, including valuable polysaccharides (cellulose derivatives, chitosan, starch, pectin) and proteins. The composition of polysaccharides makes fruit and vegetable wastes a promising resource for biopolymer production. With synthetic polymers posing serious environmental threats and packaging representing the largest application of synthetic polymers (accounting for 36% of global plastic use), fruit and vegetable waste-derived biopolymers offer a sustainable alternative for the packaging industry. While biopolymer development holds significant importance, current challenges include higher production costs and lower mechanical / barrier properties compared to conventional plastics, despite superior biodegradability. To address these limitations, researchers employ various plasticizers (glycerol, polyglycerol, sorbitol) and advanced processing techniques, including ultrasound treatment and other pre-treatment methods during raw material preparation. This study demonstrates the potential of fruit and vegetable waste as a sustainable feedstock for biopolymer production and the development of biofilms for packaging applications, while also examining the variability in biopolymer properties and the key factors influencing these characteristics.

Keywords: Biopolymers; Food Waste; Fruit and Vegetable Wastes; Packaging

ICSBE25_258

APPLICATION OF AUTOCLAVED LIGHTWEIGHT AERATED CONCRETE FOR REDUCTION OF SOIL NITROUS OXIDE EMISSION AND PO_4–P IN WATER

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Abstract: Autoclaved lightweight Aerated Concrete (AAC) is a calcium silicate-containing porous material derived from construction waste that is used as a soil conditioner. Nitrous oxide (N_2O) is one of the longest-lived greenhouse gases with a global warming potential 298 times that of carbon dioxide on a 100-y timescale. PO_4-P is an important water-quality parameter that indicates water pollution. Few studies have examined the hindrance of CO_2 emission and PO_4-Ps removal by calcium silicate. This study aims to examine the influence of AAC on N_2O gas emissions from soils at different moisture contents and PO_4-P removal from water. The effects of AAC on N_2O gas emission were tested using paddy soil amended with 50 g/kg AAC (non-carbonated) under two moisture conditions (60% and 100% water holding capacity, WHC) in l00-mL glass vials. Samples were incubated under aerobic conditions for 21 days at 25 °C. Emissions of N_2O were determined by using gas chromatography with a thermal conductivity detector. Adsorption of PO_4-P by AAC was determined by treating 0.05 g of AAC (non-carbonated and carbonated) with initial PO_4-P concentrations of 0 and 1 mg/L for 1, 3, 6, 24, 30, and 48 h shaking under constant temperature. The concentration of PO_4-P was analyzed by a continuous flow analyzer. The addition of AAC significantly decreased N_2O emissions, showing 55% and 62% reductions at 60% and 100% WHC levels, respectively, compared with the control. The interaction between AAC addition and soil moisture content on cumulative N_2O emissions was statistically significant ($p < 0.05$). The PO_4-P isotherm for time-dependent adsorption for non-carbonated AAC showed slow adsorption for 1, 3, and 6 h shaking and rapid adsorption for 24, 30, and 48 h. Our results confirmed that AAC significantly contributes to the suppression of N_2O emissions from soil, and it can be used as a good adsorbent to remove PO_4-P from low-concentration aqueous solutions.

Keywords: Aerobic Incubation; Autoclaved Lightweight Aerated Concrete; Calcium Silicate; Greenhouse Gas Emissions; Nitrous Oxide; Phosphate Adsorption

ICSBE25_283

CARBON FOOTPRINT ASSESSMENT OF A CERAMIC TABLEWARE MANUFACTURING COMPANY IN SRI LANKA

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Abstract: Environmental sustainability in the manufacturing sector has gained considerable attention due to increasingly strict environmental regulations and growing customer awareness. Consequently, ensuring sustainability has become one of the most significant challenges for manufacturing industries. The ceramic industry is generally considered a major emitter of greenhouse gases due to its well-known resource and energy intensity. Therefore, the core objective of this study is to evaluate the Carbon Footprint (CFP) of a ceramic tableware manufacturing plant in Sri Lanka and identify key activities primarily responsible for greenhouse emissions. The CFP assessment for the selected company was conducted for two functional units: tonnes of CO_2e per year (t CO_2e/year) and kilograms of CO_2e per kilogram of product (kg CO_2e/kg of product). After collecting all activity data, the annual CFP of each scope (Scope 1, Scope 2, & Scope 3) and the product CFP were assessed using relevant emission factors based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The results revealed that the total annual CFP and product CFP of this ceramic tableware manufacturing plant are 6682.84 t CO_2e/year and 4.01 kg CO_2e/ kg of product, respectively. Scope 1 emissions are the primary contributor to the total annual CFP, accounting for 51%, followed by Scope 2 emissions at 44%. Emissions generated from LPG combustion in kilns account for over 90% of the plant's direct emissions (Scope 1), while purchased electricity is the main contributor to indirect GHG emissions under Scope 2. Accordingly, LPG consumption of kilns and Electricity consumption together account for over 90% of the product CFP. Since these two emissions are primarily associated with biscuit and glost firing processes, kiln modifications to enhance energy efficiency or switching to more environmentally friendly energy sources, such as solar power and hydrogen, are essential to achieve a significant reduction in the industry's total CFP.

Keywords: Carbon Footprint; Ceramic; Greenhouse Gas; Manufacturing; Sri Lanka

ICSBE25_365

TRANSFORMATION OF ORANGE PEEL RESIDUES INTO ACTIVATED CARBON AS ADSORBENT

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Abstract: Fruit residues are an underutilized resource which can lead valorised material development for sustainable applications. This study investigates the potential of utilizing orange peels as a precursor for activated carbon synthesis through chemical activation with KOH, which can be developed as an adsorbent for pollution control or electrodes for energy storage. The structural and functional changes of raw orange peels and synthesized activated carbon samples were observed using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). FTIR analysis of raw orange peels revealed the presence of O─H, C─H, and C─O groups, significantly diminished after activation, while the C=O peak became more prominent, indicating the formation of aromatic carbon structures. These changes confirmed that KOH activation effectively promotes the development of carbon-rich surfaces, which are appropriate for adsorption. SEM images depicted a distinct morphological transformation from a dense, compact raw structure to a highly porous and textured surface in the activated samples. The pore development and increase in surface roughness were more obvious with higher KOH impregnation ratios, which denotes the role of chemical activation in increasing surface area. These findings indicate that activated carbon derived from waste orange peels has favourable functional and structural properties, highlighting an excellent potential of a low-cost, waste-derived adsorbent for environmental pollution control applications.

Keywords: Activated Carbon; Fourier Transform Infrared Spectroscopy; Orange Peels; Scanning Electron Microscopy**;** Waste-derived Adsorbent

ICSBE25_383

BRIDGING POLICY AMBITION AND DEMOLITION REALITIES: EARLY RECOGNITION OF CONDITIONS FOR CIRCULAR ECONOMY ALIGNMENT

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Abstract: The construction industry is a leading contributor to global waste generation, with demolition activities accounting for approximately 40–90% of total Construction and Demolition Waste (C&DW). Despite widespread advocacy for Circular Economy (CE) principles, demolition is still predominantly treated as a clearance exercise focused on rapid removal rather than material recovery and reuse. This gap between CE policy ambitions and demolition realities continues to undermine waste diversion targets and resource efficiency. Addressing this challenge, the present study explores how early recognition of demolition-related conditions can improve the feasibility of CE implementation. A structured literature review was combined with a preliminary practitioner survey (n = 12) in Sri Lanka to identify and validate the critical conditions shaping demolition waste outcomes. The results revealed three persistent policy–practice gaps: (1) incomplete or missing data that hinder accurate pre-demolition audits, (2) site-level constraints that limit selective dismantling, and (3) weak or unstable secondary material markets that discourage recovery. Among these, unreliable data emerged as the most influential factor (RII = 0.89). Building on these insights, the paper proposes an Early Condition Recognition Checklist (ECRC), a practical, context-sensitive framework that integrates data availability, site logistics, and market readiness into pre-demolition planning. The ECRC encourages decision-makers to anticipate project-specific constraints and tailor recovery strategies accordingly. Overall, the study provides early empirical evidence that condition-based planning can transform CE policies from aspirational directives into achievable, performance-oriented practices, fostering more predictable and sustainable demolition outcomes.

Keywords: Circular Economy; Demolition Waste; Material Recovery; Policy-practice Alignment; Pre-demolition Audits

ICSBE25_399
REPERCUSSIONS OF TEXTILE WASTE REMOVAL ON ECOSYSTEMS

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Abstract: The textile sector plays a vital of Sri Lanka's economy, contributing significantly to employment and export revenue. But at the same time, it also contributes to serious environmental problems because of the large amount of waste it produces during the cycles of production and consumption. This study examines the quality, types, and environmental consequences of textile waste while critically assessing the management strategies currently used by industry stakeholders. The effects of post-consumer waste from discarded garments and pre-consumer waste from manufacturing processes on biodiversity loss, soil health, water quality, and air pollution are examined. Semi-structured interviews were carried out with several textile companies across the country, giving detailed insights into their waste management plans, levels of compliance with environmental standards, and the operational difficulties they face in implementing sustainable practices. The findings show significant shortcomings in existing approaches, as many companies struggle to reduce waste, switch to safe disposal techniques, and switch to environmentally friendly alternatives. As a result, there is ongoing ecological degradation due to chemical effluents, soil contamination, and air emissions. To lessen these effects, this study emphasizes the critical need for more effective waste management frameworks, stronger regulatory mechanisms, and the incorporation of environmentally friendly technologies. Additionally, it emphasizes the importance of adopting a circular economy model in the Sri Lankan textile sector, emphasizing recycling, resource optimization, and closed-loop systems that reduce waste generation while boosting long-term sustainability and global competitiveness. In the end, the study promotes structural changes that strike a balance between economic growth and environmental stewardship, guaranteeing that the industry evolves in a manner that safeguards natural ecosystems and advances sustainable development goals.

Keywords: Environmental Impact; Sustainable Textiles; Textile Waste; Waste Management

ICSBE25_446

ASSESSMENT OF MICROPLASTICS IN LANDFILL LEACHATE, SOIL AT THE DUMP SITE AND SEDIMENTS OF A NEARBY WATER STREAM AROUND THE KARADIYANA OPEN DUMP SITE, SRI LANKA

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Abstract: Disposal of plastic wastes in landfills is widely considered its destination; these landfills may, however, serve as new origins to microplastic pollution to the surrounding environments. The Karadiyana dump site is one of the major municipal solid waste disposal sites in Sri Lanka, located adjacent to the Weras Ganga flowing into Bolgoda Lake. The study examines microplastic contamination of leachate and soil at the dumpsite, and sediments of the nearby Mada Ela stream. Leachate samples underwent filtration, digestion and vacuum filtration, while soil and sediment samples underwent drying, density separation, digestion and vacuum filtration. Samples were observed using a stereomicroscope. The microplastic contamination was detected in all samples. An active site showed the highest MP abundance in leachate (56.7 particles/L) compared to the inactive site (17.6 particles/L). Microplastic abundance in the soil was positively differentiated between active site (mean = 5078.7 particles/kg) and inactive site (mean = 6261.3 particles/kg), with a declining trend across the three rounds. One way-ANOVA revealed a significant impact of sampling round on abundance. The amount of microplastics in the sediments showed a downward trend over three rounds of sampling, where averages decreased from 4,197 particles/kg to 3,498 particles/kg, indicating a slight reduction. The dominant shapes of identified MPs were fibres and fragments, and the size category 0.1-1 mm was the most abundant in both soil and sediments. The most prevalent microplastics were transparent, white, and yellow. FTIR revealed the existence of polymers including polyethylene, polypropylene, polystyrene and polyethylene terephthalate. According to the Contamination Factor and Pollution Load Index, sediments showed moderate to high ecological risk, while leachate and soil indicated moderate pollution. The research demonstrates the importance of open dumpsites as a real source of microplastics and their ability to cause terrestrial and aquatic contamination. Specialized filtration systems should be installed to trap the MPs before the leachate and runoff move on.

Keywords: Abundance; Ecological Risk Assessment; Leachate; Microplastics; Sediments; Soil

ICSBE25_450

ASSESSMENT AND CHARACTERIZATION OF MICROPLASTICS PRESENCE IN THE LEACHATE FROM THE GOHAGODA DUMPSITE KANDY SRI LANKA

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Abstract: Microplastics (MPs) have emerged as a significant global environmental threat, particularly in uncontrolled open dumpsites. This research focuses on the assessment and characterization of microplastics in the leachate and surrounding soil of the Gohagoda open dumpsite in Kandy, Sri Lanka. Gohagoda dumpsite is a major municipal landfill situated near the Mahaweli River in Kandy, Sri Lanka. Samples from leachate and soil were collected in six locations across three sampling rounds. Microplastics were analysed in leachate by pre-filtration, H_2O_2 digestion, final filtration, stereomicroscope and FTIR. Microplastics were analysed in soil by density separation, H_2O_2 digestion, final filtration, stereomicroscope and FTIR. The observation of this study confirmed widespread Microplastic (MP) presence in both leachate and soil. Raw leachate locations (L1, L2, L3, L6) had higher MP concentrations than treated locations (L4, L5). In the 2nd sampling round it shows higher microplastic abundances than the 1st and 3rd sampling rounds. Predominant MP sizes were 0.1–1 mm in leachate and 2–5 mm in soil. Fragments were common in leachate, while fibres dominated in soil, with white and transparent particles originating from package material. FTIR identified PE, PP, PET, PS, and PVC polymers. Microplastics were detected in all leachate and soil samples. Average leachate MP concentrations were 14.83 particles/L (Round 1), 14.67 particles/L (Round 2), and 13.33 particles/L (Round 3). Soil samples contained 17.67, 19.17, and 10.50 particles/50g, respectively. White and transparent particles were predominant in both matrices. The Gohagoda dumpsite is a key source of microplastics, stressing the need for better waste management, filtration, policy updates, and regular monitoring to protect the environment. It is recommended to establish runoff and leachate filtration systems to trap MPs and reduce their release into the nearby Mahaweli River.

Keywords: Dumpsite Leachate; Dumpsite Soil; Microplastics

ICSBE25_453

DESIGN AND DEVELOPMENT OF A DOMESTIC FOOD WASTE DRYER

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Abstract: This paper presents an engineered solution for efficient food waste management tailored to suburban households, focusing on moisture reduction and odour control through controlled thermal drying. With irregular waste collection and limited space for composting or dumping, suburban areas often face problems such as odour, pest infestation, and environmental pollution. To address this, a mixed-method household survey involving 310 participants was conducted to identify user requirements, followed by experimental trials comparing drying methods, including thermal, microwave, and solar drying. Thermal drying was selected as the most feasible option based on drying performance, energy use, and adaptability to household settings. A Pugh matrix-based evaluation supported this selection, using data from experiments and the literature. A 1 kg-capacity prototype incorporating a 1 kW resistive heating coil, a forced-convection fan, and an insulated stainless-steel chamber was fabricated and tested. Results showed effective reduction of food waste moisture content from 80% to 20% within 30 minutes, with average energy consumption of 0.5 kWh per cycle, while maintaining safe surface temperatures and suppressing odour. This study emphasizes the urgency of suburban food waste challenges and demonstrates the domestic food waste dryer as a validated, compact, and energy-conscious solution contributing to sustainable and decentralized waste management.

Keywords: Energy-efficient Drying Systems; Food Waste Drying; Food Waste Management; Food Waste Recycling; Sustainable Waste Disposal

ICSBE25_468

DEVELOPMENT OF AN ECO-FRIENDLY PAVEMENT BLOCK INCORPORATING CALCAREOUS FOULING BIOMASS ON THE VESSEL HULLS

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Abstract: The global maritime industry faces significant challenges from marine biofouling, with barnacles and other calcareous biomass accumulation on vessel hulls leading to increased maintenance costs and environmental burdens. Meanwhile, excessive extraction of river sand for construction causes ecological damage, highlighting the urgent need for sustainable alternatives. This research aimed to develop eco-friendly pavement blocks by incorporating calcareous fouling biomass, removed from ship hulls, as a partial substitute for river sand. Calcareous biomass was collected from Colombo Dockyard PLC, cleaned, dried and processed into fine powder. Its chemical and physical properties were characterized through X-ray diffraction, bulk density, material density and porosity analyses. Pavement blocks were manufactured with biomass and fly ash at sand replacement levels of 25%, 50%, 75% and 100%. The blocks were tested for compressive strength, water absorption, shrinkage, acidity tolerance and leachability. The results demonstrated that complete sand replacement with calcareous biomass achieved a maximum compressive strength of 28.34 ± 0.088 N/mm², exceeding that of conventional blocks. Three key findings validated durability performance: a very low mass loss (< 0.02%) even under highly acidic (pH 2) conditions, minimal shrinkage (≤ 0.005% at 21 days), indicating dimensional stability and low water absorption (< 10%), reflecting reduced permeability. Environmental compatibility was confirmed, with the best mix (100% biomass) showing pH 9.28 ± 0.16, EC 205.03 ± 1.12 µS/cm and TDS 72.79 ± 0.38 ppm, while heavy metal analysis detected only Fe (0.04–0.08 mg/L), well within safe discharge limits. This study demonstrates that calcareous fouling biomass can effectively replace river sand in pavement blocks, offering a practical pathway for waste valorization, reduced resource depletion, and circular economy benefits in both maritime and construction sectors.

Keywords: Construction Sector; Environmental Sustainability; Marine Biofouling; River Sand Replacement; Waste Valorization

ICSBE25_470

CHARACTERIZATION OF MARITIME BALLAST SEDIMENTS FOR SUSTAINABLE UTILIZATION IN INNOVATIVE CONSTRUCTION MATERIALS

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Abstract: Maritime ballast sediment, a byproduct of global shipping activities, is accumulating in large quantities annually. However, its untapped mineralogical potential offers a transformative opportunity for sustainable construction. This research focuses on the characterisation and valorisation of ballast sediment as a feasible raw material for ceramic tile manufacturing, fostering circular economy practices within maritime and construction sectors. Comprehensive physicochemical analyses, including particle size distribution, elemental composition, mineralogy (as determined by XRD and XRF), and heavy metal content, demonstrate that ballast sediments are similar in composition to conventional ceramic raw materials. Seven tile formulations, with ballast sediment contents ranging from 5% to 30%, were developed and evaluated for their strength, shrinkage, water absorption, and environmental safety. The results show that tiles with higher ballast sediment content, particularly 25% and 30%, not only exceeded performance expectations but also adhered to environmental safety standards for breaking strength, water absorption, and heavy metal leaching. Thus, it is recommended to ballast sediment as a sustainable alternative material in construction, promoting circular economy principles and waste reduction. Future research should focus on increasing production scale, evaluating long-term durability, and conducting pilot projects to verify practical performance and ecological advantages. This method addresses waste management and resource scarcity issues, directly fulfilling the study's aims and supporting broader sustainability efforts.

Keywords: Ceramic Tiles; Circular Economy; Ecological Benefits; Resource Scarcity; Waste Management

ICSBE25_496

QUALITATIVELY DETERMINING CHEMICAL INDICATOR MARKERS OF WEATHERED AND VIRGIN MICROPLASTICS USING THERMAL DESORPTION-GC-MS AND SOLVENT EXTRACTION

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Abstract: Microplastics are currently present in numerous intricate environmental matrices globally. Researchers are endeavouring to devise the most efficient techniques for the precise extraction and identification of these minute particles. As a result, numerous diverse and frequently complex methodologies for quantifying microplastics have been documented in the literature. Thermal desorption gas chromatography technologies possess the capability to minimise or eliminate sample preparation, hence reducing contamination and facilitating a streamlined automated procedure. The effectiveness of solvent extraction and thermal desorption in conjunction with GC-MS for detecting chemical markers of 10 different types of microplastics was investigated in this study. Initially, virgin microplastic standards were used to find possible chemical markers. An inventive and cost-effective method was used to artificially weather these standards in order to make replication easier. The suitability of the markers for identifying the plastic polymer was assessed by comparing the markers found in both treatments with those often reported in the literature using comparable techniques. Appropriate chemical markers were found in both pure and weathered microplastics in several samples. Unlike other samples, weathered microplastics were more likely to have the right chemical indicators than fresh microplastics. Samples without pre-preparation (direct thermal desorption) were more likely to include chemical markers. Future procedures would be simplified and user and environmental exposure to toxic chemicals would be reduced if they could accurately identify microplastics without solvent extractions.

Keywords: Environmental Matrices; Extraction Techniques; Microplastics; Weathered Microplastics

ICSBE25_509

ASSESSMENT OF COMMUNITY AWARENESS OF HEAVY METAL CONTAMINATION AROUND KARADIYANA OPEN DUMPSITE

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Abstract: In many developing nations, environmental pollution and heavy metal contamination have increased due to rapid urbanization and inadequate solid waste management techniques. Without proper leachate treatment, the Karadiyana open dumpsite in Sri Lanka has been in use for more than 20 years, endangering the ecosystems and communities nearby. The purpose of this study was to determine how much the local population knew about heavy metal pollution near the Karadiyana landfill. 50 randomly chosen locals who lived close to the site were given a structured questionnaire with 11 questions as part of a descriptive survey. Population demographics, heavy metal knowledge, perceived health and environmental effects, and waste management attitudes were the main topics of the questionnaire. The data and the results were presented as percentages. The findings indicated that 100 percent of the people who responded (n = 50) were aware of visible effects like soil and water pollution, but 80 percent (n = 40) never heard of heavy metals and only 20 percent (n 10) showed any knowledge of them. Moreover, all respondents (n = 50) were not aware of health hazards caused by exposure to heavy metals, although there was evidence of contamination of waterways in the area. Residency analysis showed that half (n = 25) of them had been living near the dumpsite for more than 10 years, which augmented potential long-term exposure. Also, 60 percent (n = 30) had home gardens, and this would form a potential route of heavy metal bioaccumulation in food. The study concludes that in order to fill in knowledge gaps and reduce risks, focused awareness promotions, better risk communication, and more robust policy enforcement are necessary. Stricter soil and water quality monitoring, the encouragement of sustainable waste management techniques, and the incorporation of environmental education into community health initiatives are among the recommendations.

Keywords: Community Awareness; Environmental Health; Heavy Metal Contamination; Karadiyana Dumpsite; Waste Management

ICSBE25_510

PLASTIC POLLUTION AND ABUNDANCE IN SALT MARSH ECOSYSTEMS: A CASE STUDY OF THANANKILAPPU, CHAVAKACHCHERI, AND MANDAITIVU IN NORTHERN PROVINCE, SRI LANKA

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Abstract: Salt marshes are vital coastal ecosystems that act as natural filters for debris. However, increasing pollution, particularly plastic waste, threatens their sustainability. This study assessed debris abundance in three salt marsh sites: Thanankilappu (Site 1), Chavakachcheri (Site 2), and Mandaitivu (Site 3). Using the belt transect method (100 m × 2 m), debris was categorized into eight types: plastic, metal, glass, rubber, pharmaceuticals, wood, cloth, and paper. Debris density (items/m^2), including plastics and the Plastic Abundance Index (PAI) were calculated, and a one-way ANOVA test was performed to compare plastic abundance across the sites. A total of 3,444 debris items were recorded across the three salt marsh sites, with plastic comprising 42.68% of the total waste. The plastic density values (items/m^2) were 0.638, 4.202, and 0.9 for Sites 1, 2, and 3, respectively. The corresponding PAI values were 4.942, 24.704, and 6.588, categorizing Site 1 (Thanankilappu) and Site 3 (Mandaitivu) as high abundance sites (PAI 4.1 - 8), while Site 2 (Chavakachcheri) was grouped into the very high abundance category (PAI > 8). The one-way ANOVA test for plastic abundance across the three sites yielded a statistically significant difference ($p < 0.05$), confirming that plastic waste accumulation varied significantly among the locations. Site 2 had the highest plastic abundance, primarily due to its use as a dumping site for household and medical waste, while the pollution levels at Site 1 and Site 3 suggest a combination of localized and external pollution sources. These findings indicate that human activities and waste management practices significantly impact plastic accumulation in salt marshes. Moreover, along with the urgent need for improved waste management practices, the study suggests that increased community awareness and targeted conservation efforts should be adopted to prevent further ecosystem degradation.

Keywords: Coastal Ecosystems; Plastic Abundance Index; Plastic Pollution; Salt Marshes; Waste Management

ICSBE25_520

ELEPHANT-MEDIATED DISPERSAL OF MICROPLASTICS: A CASE STUDY OF ASHRAF NAGAR DUMPSITE AND ITS SURROUNDINGS IN AMPARA DISTRICT

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Abstract: Household waste dumped openly near forested areas is a major threat to wildlife health and the sustainability of the ecosystem. This paper explores the existence of Microplastic (MP) contamination in the dung of the elephants found in the vicinity of the Ashraff Nagar open dumpsite in the Ampara District of Sri Lanka, a known human-wildlife conflict area. Sixteen fresh dung samples were collected within a 2 km radius of the dump site and subjected to the standard chemical digestion, density separation, optical microscopy, and Fourier Transform Infrared (FTIR) spectroscopy. The findings showed MP contamination abundance varied from 3.5 ± 2.12 particles/g to 35.0 ± 9.90 particles/g, with hotspots depicting localized exposure to plastic. Particle colour categorization revealed grey and black as the most common, with (mean ± SD) grey having 14.0 ± 2.83 particles/g, and less common, yellow and orange. One-way ANOVA showed that there was no significant difference in the abundance of MP under different color categories ($p > 0.05$). The FTIR analysis revealed that most of the samples possessed weathered polyolefins (PE/PP) and some of them contained polyethylene terephthalate (PET). These results indicate a second route of dispersal of plastics into soil and vegetation, which involves the accidental ingestion and excretion of MPs by elephants foraging at contaminated dumpsites. This not only raises the risk of gastrointestinal and toxicological risks to elephants but also hastens the terrestrial MP pollution and MP release to the natural forest area. This study highlights that wild elephants foraging at the Ashraff Nagar dumpsite ingest and excrete substantial quantities of microplastics. FTIR analysis shows that the majority of these microplastics are polyolefins (PE/PP), indicating active redistribution of plastic waste by elephants into the surrounding terrestrial ecosystem.

Keywords: Ashraff Nagar Dumpsite; Elephant Dung; Microplastics; Plastic Pollution; Waste Management

ICSBE25_536

A COMPREHENSIVE INVESTIGATION OF THE PREVALENCE AND EFFECTS OF MICROPLASTIC POLLUTION: A META-ANALYSIS OF GLOBAL SEDIMENT EXTRACTION AND ANIMAL EXPOSURE RESEARCH.

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Abstract: In the given meta-analysis, the authors study the presence and the effects of the microplastic pollution of the aquatic ecosystem with a specific focus on the extraction methods of the sediment and their effects on the benthic and pelagic organisms. Nineteen studies identified 4 distinct procedures to quantify the content of microplastics using, and the most common and reliable category of measuring microplastics was identified as microplastics per kilogram of sediment (MP/kg). Analysis points out that microfibrils are unevenly distributed and some studies report very high concentrations of microplastics to 40,000 MP/kg, mainly in coastal and deep-sea environments, whilst freshwater systems are under-reported, although they are significant contributors to marine pollution. Studies of benthic species have shown that high levels frequently had negative effects, such as retarded growth, cellular injury and death, but exceptions were made, like the lugworm (*Arenicola marina*). The lobster (*Nephrops norvegicus*) of Norway was found to be sensitive to microplastics of ecological interest, which may have economic implications for fisheries. On the other hand, pelagic animals, including water fleas (*Daphnia magna*) and fish, were affected adversely by microplastics, with the effects varying with the animal species, such as the reduction in feeding and reproductive success with an increase in microplastic levels. Findings highlight the gap in knowledge on researching freshwater species, that is very high and there is a necessity to carry out research that is a more realistic reflection of real environmental conditions. Finally, the literature will conclude with the future research recommendations that are based on the important task to use homogenous units of measurement (MP/L/water, MP/kg/sediment), involving ecologically relevant microplastic concentrations in the research, and considering the physical and chemical properties of microplastics in the exposure studies. Its findings highlight that ecological risks should be assessed through controlled hypothesis-based studies to shape policies on managing the increasing number of effects that plastic pollution has on the world.

Keywords: Aquatic Ecosystems; Benthic Organisms; Microplastic Pollution; Pelagic Organisms; Sediment Extraction Techniques

ICSBE25_550

OPTIMIZING RESOURCE RECOVERY: PAPER AND CARDBOARD WASTE MANAGEMENT AND CIRCULARITY IN THE SRI LANKAN APPAREL INDUSTRY -A CASE STUDY OF THE HIRDARAMANI GROUP

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Abstract The fashion industry, a major global manufacturing sector, generates significant environmental burdens, particularly in the form of waste, where packaging predominantly paper and cardboard is becoming increasingly critical but remains relatively understudied. This research addresses a significant gap in empirical data by quantitatively analyzing the paper and cardboard waste management practices of the Hirdaramani Group in Sri Lanka, a key player in global supply networks. Monthly waste statistics from 13 Hirdaramani factories for the year 2024 were harvested from the company's internal reporting system, focusing on non-hazardous paper and cardboard waste categorized by five disposal methods. The study found that the factories generated a combined total of 409,653.25 kg of cardboard waste and over 141,000 kg of paper waste in 2024. Recycling was overwhelmingly the dominant disposal method for both cardboard (99.9%) and paper (99.5%), with minimal quantities directed towards incineration or waste-to-energy processes. The Kuruvita, Kahathuduwa, and Mercury Apparel Seethawaka plants were the primary contributors to cardboard waste, accounting for over 65% of the total. By quantifying waste generation and evaluating disposal practices, this research provides actionable pathways for companies to align with environmental requirements and circular economy principles, bridging the knowledge gap in packaging sustainability within the Sri Lankan apparel industry.

Keywords: Apparel Industry; Hirdaramani Group; Industrial Waste; Packaging Waste; Paper and Cardboard Waste Management; Recycling; Circular Economy; Sri Lanka

ADVANCING SUSTAINABLE INFRASTRUCTURE THROUGH AI, IOT, AND SMART ELECTRONIC SYSTEMS

ICSBE25_140

USE OF ARTIFICIAL INTELLIGENCE AND INTERNET OF THINGS FOR SUSTAINABLE DEVELOPMENT

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Abstract: A critical look at current technological advances shows that data-driven solutions to existing environmental, economic, and social problems are becoming increasingly widespread in sustainable development around the world. Artificial Intelligence (AI) and the Internet of Things (IoT) are playing a major role in sustainability. They are reshaping sustainable resource development and contributing to the optimal use of resources, reducing carbon footprints, and enhancing urban resilience. This study comprehensively analyses the importance of using AI and IoT for sustainable development, comparing them with current sustainability management processes, thereby providing knowledge about future trends. This research provides a unique framework that combines real-time IoT sensor networks and optimized machine learning algorithms to manage energy, human resources, and social factors. The research conceptual framework describes how building and managing smart cities can effectively manage waste, generate energy, and manage air quality, minimizing energy consumption and increasing operational efficiency. These managements also consider changes that occur when adapting to different environmental conditions. Modern operating city systems with AI and IoT have been shown to reduce energy consumption by 30% and increase sustainability by 45%. This study concludes that fostering data-driven, low-impact innovations can make a significant contribution to the United Nations Sustainable Development Goals (SDGs). As outcomes, this research offers a framework model for future urban design researchers, engineers, and architects to create intelligent and sustainable systems that incorporate AI and IoT.

Keywords: AI for Development; Design Framework of AI; IoT Applications; Smart Development; Sustainability Frameworks; Sustainable Development Goals (SDG)

ICSBE25_143

DESIGN AND ANALYSIS OF A POLYCENTRIC KNEE JOINT FOR TRANSFEMORAL PROSTHESES: A COMPREHENSIVE REVIEW

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Abstract: This paper presents a comprehensive review of the design and analysis of a polycentric knee joint for transfemoral prostheses, which is used for above-knee amputees, addressing the limitations of conventional single-axis mechanisms in replicating natural knee biomechanics. The study is focused on optimising the functionality of K3-level amputees through anatomical principles, kinematic modeling, Finite Element Analysis (FEA) and rapid prototyping. A four-bar linkage mechanism is generally used to dynamically adjust the Instantaneous Center of Rotation (ICR), enhancing gait stability and energy efficiency. Computational simulations justify structural integrity under physiological loads, while a 3D-printed prototype demonstrates kinematic feasibility. Key findings highlight improved stance-phase stability and swing-phase control compared to traditional designs, with FEA identifying critical stress concentrations for material optimization. The research bridges theoretical biomechanics and practical prosthetic development, offering a foundation for future medical enhancements with clinical trials and advancements of the prosthetic industry.

Keywords: Additive Manufacturing; Biomechanics; Finite Element Analysis; Four-bar Linkage; Polycentric Knee Joint; Transfemoral Prosthesis

ICSBE25_151

DEVELOPMENT OF MULTIVARIATE ATTENTION LSTM MODEL FOR DYNAMIC LINE RATING FORECASTING

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Abstract: As global fossil fuel reserves diminish, there's a growing impetus for nations to transition towards renewable energy sources. Sri Lanka, for instance, aims to generate 70% of its electricity from renewable sources by 2030. Achieving this target requires optimal use of the existing power transmission infrastructure, as expanding the grid is both time-consuming and expensive. Traditionally, Static Line Ratings (SLRs) are used to define line capacity, often resulting in underutilization. Dynamic Line Rating (DLR), which estimates line capacity in real time based on weather conditions, offers a more efficient solution. However, DLR prediction is highly sensitive to environmental variability and forecasting complexity. This study proposes a novel multivariate Long Short-Term Memory (LSTM) model enhanced with an attention mechanism for improved DLR forecasting. Unlike traditional models that treat weather variables independently, the proposed approach captures nonlinear interdependencies among key environmental features such as ambient temperature, cable temperature, wind speed, humidity, and solar irradiance. The attention mechanism dynamically prioritizes the most relevant inputs during forecasting, leading to improved performance. Experimental evaluation on real-world DLR data demonstrates that the proposed model achieves a prediction accuracy of 95.84%, surpassing the conventional LSTM model's 94.62%. This improvement highlights the model's superior ability to deliver accurate and robust DLR forecasts. The findings confirm that incorporating multivariate features with attention enhances forecasting precision, supporting more efficient transmission line utilization and higher renewable energy integration.

Keywords: Attention; Dynamic Line Rating; Long Short-Term Memory; Renewable Energy

ICSBE25_177

DESIGN AND SIMULATION OF AN OPTIMIZED CARDIOVASCULAR STENT MODEL FOR REDUCTION OF RESTENOSIS

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Abstract: Cardiovascular stents are lifesaving devices used to treat blocked arteries, but their long-term success is often limited by restenosis, the re-narrowing of the artery after implantation. This study aimed to design a stent that reduces restenosis while maintaining mechanical stability. Using computational modelling, five stent designs with different geometric patterns were created and tested under simulated physiological conditions. Finite element analysis evaluated each stent's performance during expansion, bending, and compression. Key metrics included recoil (loss of diameter after deployment), foreshortening (reduction in length), and stress distribution. Results showed that stent geometry directly influences mechanical behaviour. A design with uniform geometry (Stent D) exhibited low recoil (4.27%) but high compressive stress (120 MPa), while flexible open-cell designs (Stents B and C) minimized bending stress (0.0306 - 0.0328 MPa). A multi-criteria analysis ranked Stent C as optimal, balancing flexibility and radial strength with the lowest risk of restenosis. These findings highlight the importance of geometric optimization in stent design. Future work should validate these results through experimental testing and clinical trials. This study lays the groundwork for developing next-generation stents that improve patient outcomes by reducing restenosis.

Keywords: Cardiovascular Stent; Computational Modeling; Mechanical Testing; Restenosis Prevention; Stent Design Optimization

ICSBE25_227

SMART HEALTH BAND: AI-DRIVEN IOT SOLUTION FOR ENHANCED PATIENT MONITORING AND SAFETY

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Abstract: The need for improving patient safety and facilitating remote patient monitoring has driven innovative wearable technologies. This project aims at developing an AI-powered IoT device-the Smart Health Band-capable of constantly monitoring all major health parameters such as body temperature, blood pressure, heart rate, and oxygen saturation. The health band features state-of-the-art AI algorithms that can analyze data in real time, recognize anomalies, and immediately alert patients and healthcare professionals. Ensuring the safety of patients, particularly for older or high-risk patients, the band also includes GPS tracking and fall detection. Patients and careers can track long-term health trends, access health reports, and receive prescription reminders through a user-friendly mobile application. The suggested remedy will increase the general quality of healthcare delivery and reduce hospital readmissions, thus enhancing patient outcomes. It ensures dependable operation of the Smart Health Band with a robust cloud-based architecture for data processing and storage. Security in the flow of existing wearable data to cloud servers is ensured through encrypted communication protocols that protect the confidentiality of patient information and offer compliance with healthcare regulations such as GDPR and HIPAA. The system will be capable of adapting and increasing anomaly detection accuracy over a period by utilizing machine learning models, therefore providing users with personalized health information. Also, the energy-efficient components of the health band extend battery life and allow for continuous monitoring over extended periods of time. Empowering people to take control of their health and creating a more proactive, connected healthcare experience have been achieved by bridging the gap between technology and healthcare through this innovative approach.

Keywords: AI-driven IoT; Healthcare Innovation; Patient Safety; Real-time Health Metrics; Remote Patient Monitoring; Smart Health Band

ICSBE25_291

COMPARATIVE ANALYSIS OF MACHINE LEARNING ALGORITHMS TO PREDICT THE BOND SHEAR STRESS BETWEEN CFRP AND CONCRETE

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Abstract: Externally bonded Carbon Fiber Reinforced Polymer (CFRP) systems have emerged as a reliable solution for upgrading the mechanical performance and durability of reinforced concrete structures. However, the interfacial bond strength between CFRP and concrete is a critical factor governing the overall performance of these strengthening systems. Inadequate bonding can result in premature debonding, thereby diminishing the load-bearing capacity and compromising structural integrity. This study examines the impact of key geometric and material parameters, including bond length, bond width, CFRP thickness, concrete compressive strength and CFRP stiffness on the interfacial bond strength of CFRP–concrete systems. A detailed literature review was undertaken to identify the most influential bond parameters, and a comprehensive dataset of 855 experimental results was compiled from previous studies. Four supervised machine learning algorithms, Support Vector Machine (SVM), Gamma Likelihood (GL), Random Forest (RF) and Extreme Gradient Boosting (XGB) were employed to develop predictive models. Model performance was assessed using the Coefficient of Determination (R^2), Mean Absolute Error (MAE) and Mean Squared Error (MSE). The results indicate that the ML models, particularly XGB and RF, achieved superior prediction accuracy, demonstrating their potential as effective tools for practical structural engineering applications. Overall, this research underscores the importance of data-driven methods in enhancing the evaluation and design of CFRP-strengthened concrete structures.

Keywords: Carbon Fiber Reinforced Polymer; Interfacial Debonding; Machine Learning; Prediction Accuracy; Structural Retrofitting

ICSBE25_322

A MACHINE LEARNING-BASED FRAMEWORK FOR PREDICTING CFRP–STEEL BOND STRENGTH INCORPORATING BOND SENSITIVE PARAMETERS

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Abstract: Assessment and retrofitting of steel structures approaching the limits of their design life has become a pressing challenge for countries like Sri Lanka, particularly where much of the infrastructure is located in severe marine environments. Carbon Fibre Reinforced Polymer (CFRP) retrofitting has proven effective for deteriorated steel structures due to its high strength-to-weight ratio, corrosion resistance, and ease of installation. However, its success critically depends on the bond strength at the CFRP–steel interface, which is highly sensitive to the steel surface condition. The final prepared surface condition is influenced by both the initial deterioration state and the chosen surface treatment method. Conventional visual inspection methods used to evaluate surface quality are subjective and lack integration with predictive analytical models, limiting reliability and reproducibility. This paper reviews recent developments in digital image processing and Machine Learning (ML) and proposes a novel framework to quantitatively predict CFRP–Steel bond strength using photographic surface inspection. The approach involves grayscale conversion, Otsu's thresholding, and feature extraction using the Gray-Level Co-occurrence Matrix (GLCM) combined with colour spaces to capture surface texture and chromaticity changes. These visual features, along with mechanical parameters of CFRP and adhesive properties, will be used to train ML models such as Gradient Boosted Decision Trees (GBDT), Random Forest (RF), and Artificial Neural Networks (ANN). The proposed methodology aims to deliver a replicable, data-driven, and interpretable predictive tool to support engineers in making more accurate and automated assessment decisions in CFRP retrofitting projects, ultimately improving structural resilience and extending service life.

Keywords: CFRP–Steel Bonding; Digital Surface Assessment; Image Processing; Machine Learning; Structural Retrofitting; Surface Preparation

ICSBE25_421

RECENT DEVELOPMENTS OF MACHINE LEARNING APPLICATIONS AND LIFE CYCLE ANALYSIS IN SUPPLEMENTARY CEMENTITIOUS MATERIALS INCORPORATED MORTAR

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Abstract: Mortar, a widely used cement-based construction material, is associated with considerable CO_2 emissions during its production, especially due to the utilization of cement. Additionally, the intensive extraction of natural raw materials required for cement production contributes significantly to environmental pressure. Hence, the application of Supplementary Cementitious Materials (SCMs) combined with life cycle assessment is considered a feasible strategy among the proposed measures to mitigate this environmental impact. However, conducting experiments requires significant time, specialized equipment, and a dedicated space for testing and storing samples. In this regard, Machine Learning (ML) techniques are gaining prominence in developing effective prediction models to foresee the properties of cementitious compounds with added SCMs. This study provides a systematic examination of machine learning techniques and life cycle analysis applied to mortar incorporating supplementary cementitious materials (SCMs). The most dominant SCMs capable of lowering the CO_2 emissions significantly were identified, along with the rising trends in ML techniques to predict the engineering properties of mortar.

Keywords: CO_2 Emission; Life Cycle Analysis; Machine Learning; Mortar; Supplementary Cementitious Materials

ICSBE25_452

SMART SENSOR NETWORK SYSTEM FOR STRUCTURAL HEALTH MONITORING

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Abstract: Monitoring the condition of civil infrastructure is crucial for keeping structures safe and slowing down long-term deterioration. Traditional crack detection methods, however, often struggle with accurately pointing out cracks and remaining reliable when environmental conditions change. In this study, a more practical and combined approach is introduced to overcome these limitations. The process begins with simple image analysis; photographs taken using drones or handheld cameras are examined to identify where cracks are likely to be present. Once these areas are located, custom-built capacitive sensors along with temperature, humidity, and thickness measurement modules are placed directly at those points. This setup enables continuous collection of data that reflects the real behaviour of the material. To make sense of this data, various machine learning models such as Support Vector Machine, Multilayer Perceptron, and XGBoost were tested to classify whether a region is cracked or not and to understand how the crack is developing. The results showed that this combined method performs well even when environmental factors fluctuate, producing reliable accuracy over time. Overall, the work highlights how visual inspection and sensor-based monitoring can complement each other. By merging these two stages with predictive modelling, the proposed framework offers a more dependable, scalable, and practical solution for crack detection. This approach can help improve maintenance planning, reduce unnecessary inspections, and ultimately extend the lifespan of important civil infrastructure.

Keywords: Capacitive Sensing; Civil infrastructure; Crack Localization; Crack Monitoring

ICSBE25_458

DEVELOPMENT OF COST-EFFECTIVE TRACKING AND CLASSIFICATION SYSTEM OF HUMAN SPERMATOZOA EXPOSED IN SIMULATED MICROGRAVITY

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Abstract Sperm motility is a vital parameter in assessing male fertility and is commonly measured using Computer-Assisted Sperm Analysis (CASA) systems. However, commercial CASA platforms are costly, proprietary, and lack flexibility for specialized research environments such as simulated microgravity. This study presents the development of a Python-based CASA tool designed for real-time sperm tracking, velocity analysis, and motility classification. The system leverages OpenCV for video processing, employs MOG2 background subtraction for object detection, and uses a nearest-neighbour approach for tracking individual sperm cells. The Graphical User Interface (GUI) provides user control over parameters and visualizes sperm trajectories and velocities in real-time. Classification is performed based on sperm velocity into three motility categories: rapid progressive (≥25 µm/s), slow progressive (5–25 µm/s), and non-progressive (0–5 µm/s). This current version has been tested on microscope video footages 3 times per sample video, which showing the similar results in sperm tracking and categorization. These findings confirmed the developed tool as a dependable tool for reproductive studies in altered gravity, addressing a critical gap in space biology research. By eliminating the need for proprietary software or specialized hardware, CASA version 9d lowers the barrier for advanced sperm motility analysis and lays the groundwork for future enhancements through machine learning integration. This CASA tool represents a significant step toward accessible and customizable reproductive health diagnostics.

Keywords: Computer-Assisted Sperm Analysis; Simulated Microgravity; Sperm Motility; Velocity Classification

ICSBE25_477

DESIGN OF AN AUTOMATIC SANITARY NAPKIN COUNTING AND BATCHING SYSTEM

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Abstract: The design of a high-speed sanitary napkin counting and batching system, based on an analysis of existing technologies and modern machinery, is the most concerning aspect of the study. Sanitary napkin packaging is a fast, repetitive task. If manually done, it creates significant challenges; hence, it is highly labour-intensive and initiates hygiene-related problems. Moreover, production rates become inconsistent. The project aimed at designing an automatic packing system for sanitary napkins at high speed, designed to address these inefficiencies and substantially enhance production efficiency and product quality. The existing packaging rate is confined to 600 napkins/minute due to the manual process. The research study on various technologies and methods helped to get generalized methodologies for effective solution packaging. The proposed automated system integrates industrial automation, including PLC, servo-driven mechanisms, optical sensors, and a precision conveyor system, to optimize the high-speed packaging process. It is capable of packing 800 napkins/minute more precisely, which is a 25% increase in production rate while accommodating different batch sizes. Calculations and simulations in detail were performed to arrive at the required bearings, couplings, conveyor speeds, motor power requirements, and structural integrity. Furthermore, return on investment calculations proved that the return on investment is within 3 years. This will be able to provide a scalable and adaptable solution for high-speed sanitary napkin counting and batching operations, following the lean manufacturing principles. Key outputs include the complete avoidance of human intervention, high accuracy and consistency in batch formation, huge improvement in production efficiency, and better scalability for future demands.

Keywords: Automated Counting and Batching Systems; High-speed Packaging; Hygienic Product Counting Machines; PLC-controlled Pad Stacker; Sanitary Napkins Packing Systems

ICSBE25_479

MACHINE LEARNING BASED MODEL TO PREDICT THE CORROSION BEHAVIOR OF STRUCTURAL STEEL IN INDUSTRIAL ENVIRONMENTS

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Abstract: Atmospheric corrosion poses a persistent challenge in engineering, particularly in industrial and coastal regions. This study develops an Artificial Neural Network (ANN), a machine learning model, to accurately predict the corrosion rate (K) of structural steel. The model incorporates a comprehensive set of meteorological and electrochemical parameters, including temperature, relative humidity, rainfall, time of wetness, sunshine hours, wind speed, SO_2 and chloride deposition rates in conjunction with microstructural parameters: corrosion layer depth, surface roughness, and Fe/O ratio, obtained via SEM and EDS analyses. Corrosion monitoring data from 180 mild steel samples exposed to diverse industrial environmental conditions were analyzed using weight loss measurements and microstructural characterization techniques. The optimized ANN model achieved high predictive accuracy ($R^2 \approx 0.9989$–0.9990), surpassing traditional regression models. Sensitivity analysis identified corrosion layer depth and surface roughness as the most influential factors. Comparative evaluation confirmed the ANN's superior predictive capability, yielding the lowest prediction errors (RMSE and MAPE) across all datasets. These findings highlight the potential of integrating machine learning with advanced material characterization for improved corrosion prediction and more effective steel infrastructure management.

Keywords: ANN; Corrosion Rate; Electrochemical; Machine Learning; Material Characterization; Meteorological; Structural Steel

ICSBE25_545

DESIGN A SEMI-AUTOMATED VISION BASED COCONUT PARING MACHINE

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Abstract: Coconut paring is one of the most critical steps in coconut processing, which involves removing the brown skin called Testa from the coconut kernel. That is essential for producing high-quality coconut-based products. However, the currently used manual paring method is labour-intensive. The workers who engaged in the process of coconut paring are highly demanded depending on their experience level and skillfulness. Manual process has many disadvantages: the process is slow and risky, and inefficient. Other than that, existing machine-assisted methods which not as widely used as manual paring, along with the inefficiencies and complexities. Design and development of a coconut paring machine is intended to overcome the existing challenges and limitations while improving efficiency, consistency, and safety of the paring process by examining the problems posed by traditional paring methods and the limitations of existing machines. This initiative aims to reduce coconut meat wastage, ensure consistent paring thickness across coconuts of varying sizes, and improve overall process efficiency compared to traditional methods. Introducing the special mechanism assisted with an image processing technique for the pairing process to create an efficient and robust solution. A thorough analysis, development and testing aiming to develop an innovative, cost-effective and user-friendly solution. This innovation significantly benefits for the coconut processing industry not only for large-scale industries but also for the medium and small-scale industries.

Keywords: Coconut Pairing; Image Processing; Labour-intensive; Manual Pairing

SUSTAINABLE TOURISM: HOSPITALITY, WELLNESS, AND INFRASTRUCTURE

ICSBE25_287

SERVICE FLOW CHALLENGES IN THE KOLLUPITIYA AND PORT CITY AREA: AN ANALYSIS OF HOTEL OPERATIONS AND GUEST SATISFACTION

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Abstract: The high rate of urbanization increases the operational demands in high-density hospitality settings, especially in tourism-based emerging economies that are limited by poor infrastructure and a lack of sufficient staff. The Kollupitiya-Port City corridor in Colombo, which accounts for 32% of the premium room nights in Sri Lanka, is a prime example of this pressure point, where inefficiencies in service flow pose a potential threat to guest satisfaction and resilience in the sector. This explanatory mixed-methods study, conducted between January and May 2025, examined critical bottlenecks by analyzing 650 verified guest reviews from 16 classified hotels. The study employed natural language processing to categorize feedback, structural equation modelling to determine causal relationships, and inferential statistics to measure the probability of failure. Findings indicate that the process reliability ($\beta = 0.51$), staff responsiveness ($\beta = 0.42$), and tangible infrastructure ($\beta = 0.38$) are the key statistically significant predictors of satisfaction. The critical inefficiencies are the old check-in systems that delay the process (dissatisfaction odds ratio = 4.2), the communication gaps due to multilingualism (correlation with dissatisfaction = 0.67), the disconnects in the food and beverage workflow that affected 43% of all orders, and the lack of consistency in housekeeping between shifts. The analysis of the quality gaps showed that there were serious gaps: a reliability gap (-23.5 percentage points) and a responsiveness gap (-16.8 points). To overcome these, the study proposes the Service Flow Optimization Matrix, which combines (1) Technology solutions (cloud-based property management systems, AI translation tools); (2) Human capital development (language skill incentives, cross-functional training); and (3) Process redesign (pre-arrival profiling, standardized operating procedures). These results confirm service dimension weightings of emerging economies and prove operational resilience as a quantifiable construct. The practical implications are digitization roadmaps that can be implemented immediately, a Service Resilience Index to compare with industry peers, and practical strategies that can be used to improve resilience in the face of staffing and infrastructure limitations. This framework offers definitive pathways of hospitality ecosystems in rapidly urbanizing tourism-based economies where the efficiency of service flows has a direct impact on the stability and competitiveness of the economy.

Keywords: Customer Satisfaction; Guest Experience; Hospitality Sector; Operational Efficiency**;** Service Delivery; Service Flow Challenges

ICSBE25_293

BARRIERS TO SUSTAINABLE YOGA TOURISM DEVELOPMENT IN MIRISSA, SRI LANKA

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Abstract: Yoga tourism represents an underdeveloped sector in the Sri Lankan wellness economy, with Mirissa having the potential to become a comprehensive tourist coast. Mirissa was selected due to its prominence as a key coastal tourism destination in Sri Lanka, with its diversity of natural attractions and tourism activities such as whale watching, surfing, and ecological diversity. Its importance as an economic driver to local communities through tourism-related employment and business ventures, and emerging sustainability challenges such as over-tourism and environmental degradation, make it an ideal place to explore barriers and opportunities for sustainable yoga tourism development. The current research introduces a Dual-Pressure Framework to investigate the restraints that arise because of interacting external pressures (infrastructure deficit, policy gap, and seasonal volatility) and internal pressures (cultural dissonance, skill gap, and digital invisibility) in young destinations in a systematic manner. Using mixed methods, 30 yoga instructors were surveyed with the accompanied interviews of the stakeholders, which included five participants. Significant limitations were noted: lack of infrastructure, rated by 80% of instructors as a major barrier; changes in demand driven by the monsoon season, with a peak in November to March considered by 63.3%; cultural-linguistic tension, with a decline in quality of service noted by 50%; lack of digital visibility, with poor online visibility named by 90%; and irregular instructor quality, reported by 53.3%. The suggested solutions are seasonal repurposing, where losses during the low season would be recouped with online workshops and webinars, and surf-yoga synergy, where the year-round destination would be bundled with yoga and the existing surf tourism infrastructure in Mirissa. The results recommend the standardization of policy by certification of instructors and accommodations, community-based business strategies like homestay affiliations, and digital marketing alliances. This Dual-Pressure Framework thus provides an emulable template to new wellness destinations dealing with similar problems, focusing on resilience and intersectoral combination

Keywords: Barriers; Mirissa; Sustainable Development; Yoga Instructors; Yoga Tourism

ICSBE25_537

ASSESSMENT OF THE ADOPTION OF GREEN BUILDING PRACTICES AND SOCIAL SUSTAINABILITY OUTCOMES IN SRI LANKA'S HOTEL INDUSTRY

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Abstract: The hospitality sector plays a pivotal role in advancing sustainable development, yet hotels are among the most resource-intensive operations, consuming substantial amounts of energy and water while generating significant waste and emissions. This study assesses the adoption of green building practices and associated social sustainability outcomes in Sri Lanka's hotel industry, with a particular focus on operational strategies, workforce engagement, and community integration. Using a qualitative research design, nine hotels of varying size, category, and ownership were examined through onsite visits, structured interviews, and online surveys. Thematic analysis identified both common practices and key variations in adoption levels. Results indicate that while energy efficiency measures, waste segregation, and water conservation technologies are widely implemented, advanced practices such as modular construction, high-efficiency air purification, greywater recycling, and renewable energy integration remain selective and concentrated in larger, resource-rich hotels. Similarly, social sustainability initiatives, ranging from gender-inclusive hiring, staff training, and occupational health and safety programs to local community engagement and cultural preservation, were present but varied significantly across hotels. Medium-scale and brand-affiliated hotels demonstrated comprehensive strategies, while smaller eco-lodges often implemented fragmented or narrowly focused practices. Barriers included high initial investment costs, limited access to sustainable materials, knowledge gaps, and weak government incentives. Despite these challenges, most hotels reported clear benefits such as reduced operational costs, enhanced brand reputation, and increased guest satisfaction, underscoring the business case for sustainability. This study highlights both achievements and gaps in Sri Lanka's hospitality sector, emphasizing the need for targeted policy support, financial incentives, and capacity-building initiatives to promote sector-wide adoption of integrated green building and social sustainability practices. The findings contribute to ongoing debates on sustainable tourism by linking environmental stewardship with social equity.

Keywords: Green Building; Hospitality Management; Hotel Industry; Social Sustainability; Sri Lanka; Sustainable Tourism

SPECIAL SESSION ON OFF-GRID RENEWABLE ENERGY PRODUCTION AND STORAGE WITH ORGANIC RANKINE CYCLE, SOLAR, AND WASTE (RESORCS) PROJECT

ICSBE25_572

GENDER EQUALITY AND SOCIAL INCLUSION IN ENERGY SECTOR GOVERNANCE: A CASE STUDY FROM SRI LANKA

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Abstract: Gender Equality and Social Inclusion (GESI) has been recognized as a key driver of the Sustainable Development Goals due to its impact as a social component. This study explores up to what level the GESI considerations have been integrated into the Sri Lankan energy sector as a case study. A questionnaire was developed to assess how GESI concerns are addressed within the energy sector, and a pilot test was conducted to evaluate its effectiveness. The prepared questionnaire was distributed among the participants in two main formats, including a printed hard copy and a link to a Google Form. Apart from those two methods, an interview with a legal officer was also conducted to evaluate the effectiveness of conducting an interview instead of solely relying on the questionnaire. The received results reflect that the understanding of GESI among the officials is not at a satisfactory level, and institutional support for mainstreaming GESI remains ineffective, despite genuine interest among officials for equity and inclusion. In the survey, several major challenges were identified, including a lack of financial support, insufficient training, inadequate legal frameworks and policies, cultural barriers, and communication gaps. The study also presents practical recommendations proposed by the participating officials, drawing on their expertise and experience, to support the integration of GESI principles into the future energy sector and promote a more equitable and inclusive industry.

Keywords: Energy Access; Energy Poverty; Gender Mainstreaming; Questionnaire Survey; Sustainable Development

ICSBE25_574

A NEXT-GENERATION SOLAR THERMAL POWER PLANT CONCEPT COMBINING ORC TURBINE TECHNOLOGY WITH LOW-TEMPERATURE THERMAL STORAGE

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Abstract: Due to the growing demand for reliable and sustainable power generation in off-grid and rural regions, there exists a need for solar thermal systems integrated with Organic Rankine Cycle (ORC) turbines. Conventional high-temperature molten salt storage has been extensively studied, yet these systems face practical barriers, including crystallization, corrosion, and high cost. The aim of this study was to address current gaps in the field-scale validation of water-based Thermal Energy Storage (TES) integrated with solar-ORC systems. This paper presents the design and development of a next-generation solar thermal power plant in Hambantota, Sri Lanka, combining Parabolic Trough Collectors (PTCs), a twin-tank water-based TES system, and a low-temperature ORC turbine operating at 95 °C. The methodology includes thermal modelling, flow rate optimization, and system integration strategies to ensure efficient solar energy capture and storage utilization. Preliminary results demonstrate the feasibility of charging and discharging cycles with sufficient stability to maintain continuous ORC operation. Water was selected as the storage medium due to its cost-effectiveness, operational simplicity, and absence of crystallization risks, making it highly compatible with low-temperature ORC operation. The plant configuration includes 32 PTC modules delivering 256 kW of thermal energy, coupled with modular 30 m^3 insulated hot and cold storage tanks. A dedicated control system with automated valves and one-second sampling instrumentation ensures stable operation and optimized heat transfer under varying irradiance conditions. The outcomes indicate that low-temperature water-based TES is a viable and scalable solution, enabling cost-effective renewable energy generation for rural electrification and sustainable industrial applications in sun-rich regions.

Keywords: Low-temperature Power Generation; Parabolic Trough Collectors; Rankine Cycle; Renewable Energy Systems; Solar Thermal Power; Water-based Thermal Energy Storage

ICSBE25_576

DEVELOPMENT OF THE ELECTRICAL SYSTEM FOR A GRID-CONNECTED SOLAR THERMAL ORGANIC RANKINE CYCLE HEAT ENGINE

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Abstract: There are many forms of renewable energy that can be used to support society through the current energy transition. Concentrating solar thermal systems linked through a heat engine to the grid are an underutilised potential option. This paper discusses the electric drive train requirements for a concentrating solar thermal system linked to an Organic Rankine Cycle (ORC) heat engine. The requirements of bi-directional power flow and to decouple the heat engine rotational frequency with the grid frequency drive the need for back-to-back inverters to be used to connect the heat engine to the grid. A simulation of the drive train comprising an active front end, grid-connected inverter, and a load is used to demonstrate the system operating exporting power. The system is able to synchronise with the grid, export 20 kW into a shared 50 kW resistive load with the grid, decouple input and output rotational speeds, and remain stable across the typical operating conditions. The system will be implemented using off-the-shelf inverter hardware at a site in Sri Lanka to demonstrate its capability.

Keywords: Back-to-back Inverter; Grid Connected System; Organic Rankine Cycle Electrical Drivetrain; Requirements and Specifications

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