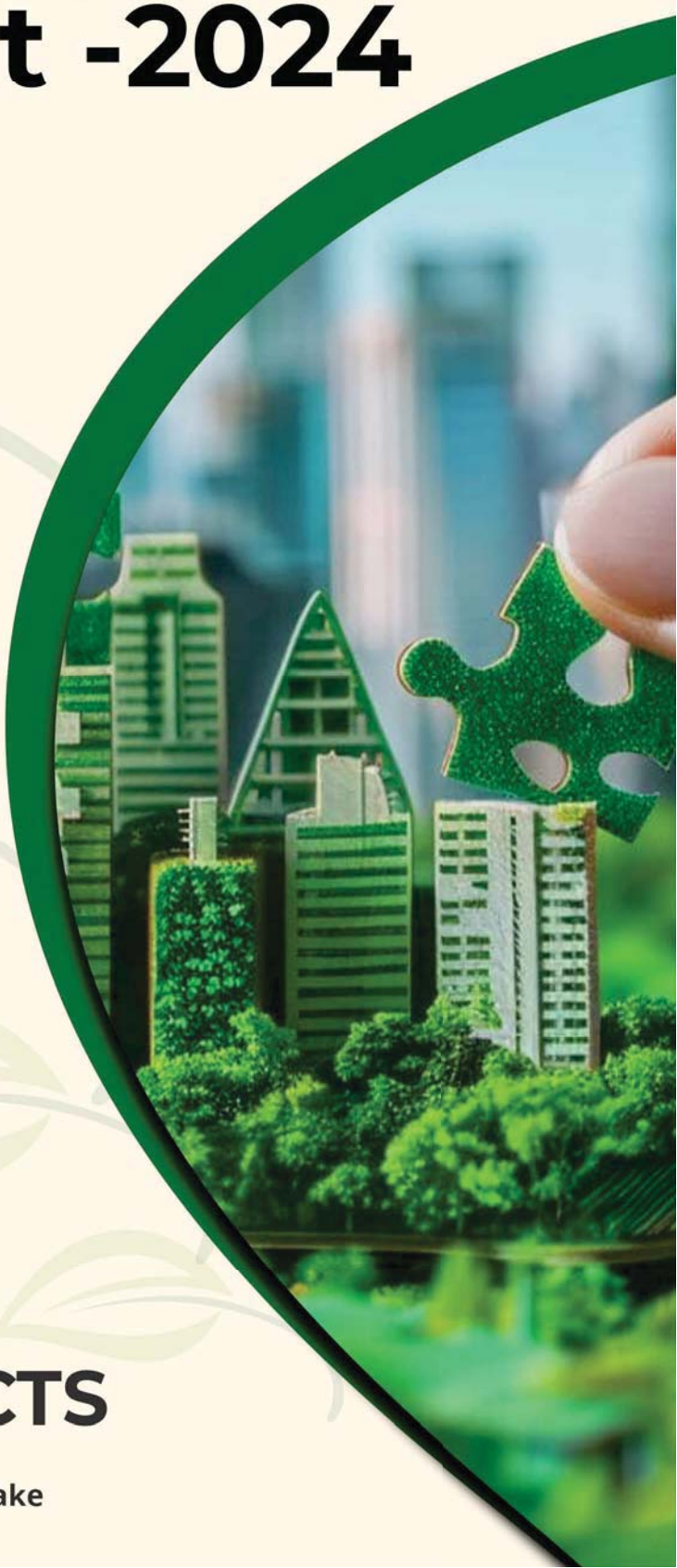
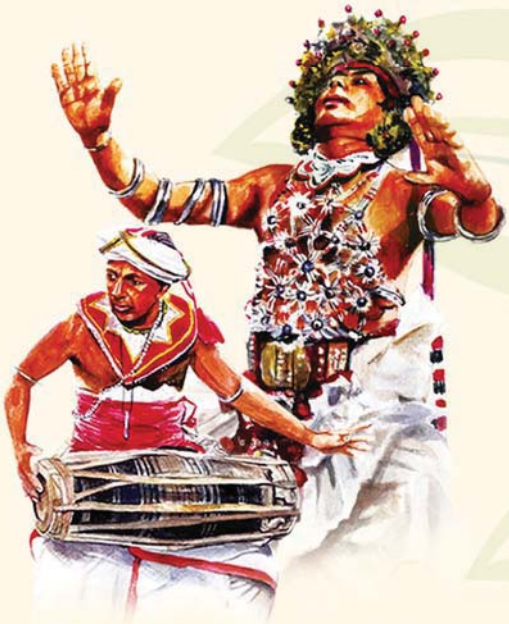
The 15th International Conference on

Sustainable Built Environment -2024





The Kandy Conference

BOOK OF ABSTRACTS

Editors
Prof. Ranjith Dissanayake | Dr. Pradeep Gajanayake

Abstract Book of the 15th International Conference on Sustainable Built Environment (ICSBE) 2024

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

ISSN 3021-6966

Published by: Graduate Associate Professional (Pvt) Ltd
Science Tower, 120/10A, Vidya Mawatha, Colombo 07

PREFACE

It is with great pleasure that we present the abstract book of the 15th International Conference on Sustainable Built Environment (ICSBE) 2024. 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 20th to 22nd December 2024. 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 15th International Conference on Sustainable Built Environment (ICSBE) 2024
20th to 22nd December 2024, Kandy, Sri Lanka

MESSAGE FROM THE CHIEF GUEST

I am privileged to share this message as the Chief Guest on the occasion of the 15th International Conference on the Sustainable Built Environment (ICSBE 2024). This long-standing event has clearly become a globally recognized platform, showcasing Sri Lanka's contributions to sustainability research and innovation. Events like this serve as catalysts for fostering resilience and responsibility while driving impactful solutions that resonate both nationally and internationally.

The Kandy conference emphasizes the multidisciplinary nature of sustainable development, particularly by promoting academic and industrial collaborations. The technical sessions of the conference, centered around the theme "Building Sustainable Nations," aligns deeply with the United Nations' 17 Sustainable Development Goals. I believe this theme highlights the importance of sustainability not only as an environmental priority but also as an economic opportunity. Sri Lanka and many nations still have much to achieve regarding these SDGs, but conferences like this encourage the ethos and promote sustainable development.

I commend the organizing committee, led by Prof. Ranjith Dissanayake, for their outstanding efforts in sustaining this conference and ensuring its success. Reaching its fifteenth milestone is no small feat and reflects the dedication and vision of all involved. As an academic and a researcher, I deeply appreciate the commitment required to maintain such a vibrant conference series.

The knowledge shared here should not end within these walls but instead, inspire actionable outcomes in your respective fields. I trust that ICSBE 2024 will generate impactful insights and foster meaningful collaborations that extend beyond this event, shaping a more sustainable and resilient world.

Wishing the conference every success!

Thank You

Prof. Lalith Gamage
Vice Chancellor/ CEO of Sri Lanka Institute of Information Technology (SLIIT)

Massage from the Conference Co-Chairs

It is a pleasure for us to welcome all the participants to the 15th International Conference on Sustainable Built Environment (ICSBE) 2024 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
Prof. Chintha Jayasinghe
Prof. Sudhira De Silva
Prof. Upul Attanayake
Prof. Ayantha Gomes
Prof. Ajith Dolage
Prof. Chaminda Bandara
Dr. Ajith Thambo
Dr. Balasubramaniam Janarthanan
Dr. K.H.P Madusanka
Eng. Shiromal Fernando

The 15th International Conference on Sustainable Built Environment (ICSBE) 2024

A NEW TAKE ON SUSTAINABLE INFRASTRUCTURE: USING DAMS, REGULATORS AND PUMPS TO IMPROVE ENVIRONMENTAL SUSTAINABILITY IN REGULATED RIVER SYSTEMS

Angus Webb
University of Melbourne

Abstract: The vast majority of the world's great rivers are heavily regulated to supply water for human uses. The economic and social benefits that come from this regulation are soured, however, by a legacy of severe environmental degradation. Over the past 30 years, *environmental flows* have emerged as a major tool to partly restore these environments. Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well being that depend on these ecosystems. In regulated river systems, environmental flows are delivered through modifications in dam operations, through reallocation of water from agricultural to environmental purposes, and through the use of pumps, weirs and other infrastructure to deliver water to floodplain environments. Australia has been a world leader in the implementation of large-scale environmental flows. In 2012, the Australian Federal Government legislated the Murray-Darling Basin Plan, aimed at improving the sustainability of the system into the future. A major feature of the Plan was the allocation of substantial environmental flows. However, to make best use of this water for the environment, substantial new infrastructure and changes to operation of existing infrastructure, was required.I will outline examples of where existing and new infrastructure has been used to improve environmental outcomes in the Murray-Darling basin. This approach allows us to do 'more with less' when it comes to environmental outcomes while maintaining irrigated agricultural output. The Australian experience supports the roll-out of similar programs in developed and developing river systems across the world, ably demonstrating how built infrastructure can be used to improve environmental outcomes in heavily developed river systems.

OVERCOMING DATA SCARCITY IN 3D FINITE ELEMENT ANALYSIS: A SYNERGISTIC APPROACH WITH 3D MEASUREMENT AND LARGE LANGUAGE MODELS

Pang-jo Chun
The University of Tokyo

Abstract: Numerous existing bridges lack as-built drawings and were constructed based on unclear standards. These bridges are simultaneously facing significant aging and deterioration. Assessing the remaining capacity of these bridges is a pressing issue, but constructing the necessary 3D Finite Element Method (FEM) models for this purpose is labor-intensive. Efficient modeling techniques are essential, especially for large-scale bridge surveys. This study proposes an automated 3D FEM model construction method that integrates damage detection AI-based image analysis, shape assessment AI-based point cloud analysis, and available bridge specifications. However, modeling real-world bridges often involves incomplete information, such as material properties and the geometry of obscured components. To address this, we utilize generative AI to supplement missing data, incorporating civil engineering expert knowledge to ensure model validity. This approach enables efficient FEM analysis of numerous bridges with reduced effort. This paper details the proposed methodology and demonstrates its effectiveness through a real-world bridge case study.

ENHANCING CONSTRUCTION PRODUCTIVITY: INNOVATIONS AND INSIGHTS

Janaka Ruwanpura
University of Calgary

Abstract: Improving productivity is a cornerstone of innovation and competitiveness in the construction industry. Yet, the sector continues to face challenges in adopting systematic approaches to enhance productivity amidst diverse technical, managerial, and labour-related complexities. This keynote introduces the concept of the Construction Productivity Improvement Officer (CPIO), a dedicated role designed to drive accountability, sustainability, and efficiency in productivity improvement initiatives on construction sites, which was developed and successfully implemented in construction projects in Canada and the USA. Drawing from extensive research and collaborative implementation projects at the University of Calgary, this presentation outlines the impact of integrating structured frameworks and advanced other innovative tools. These innovations demonstrate measurable improvements in tool time, productivity, and worker satisfaction. By sharing real-world applications and test case outcomes, this keynote provides actionable insights into overcoming barriers, integrating new practices, and unlocking the potential for sustained productivity gains in construction.

ICSBE24_130

INFORMAL FINANCING MECHANISMS ADOPTED BY FEMALE SMALL-SCALE FISH PROCESSORS IN FACE OF CLIMATE CHANGE IMPACTS IN SRI LANKA

M.M.S.C. Senevirathne*, D.A.M. De Silva, M. Esham
Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
**Correspondence E-mail: sulochana@agri.sab.ac.lk, TP: +94713631454*

Abstract: Climate change poses significant challenges to small-scale fisheries communities, particularly affecting female fish processors in Sri Lanka. This study explores the informal financing mechanisms adopted by female fish processors to manage the impacts of climate-induced hazards on their livelihoods. The data collected through surveys and focus group interviews with 60 female fish processors in Tangalle, Negombo, and Ambalangoda during 2023- 2024 period. The study provides insights into the challenges faced and the informal financial mechanisms employed to cope with disruptions caused by extreme weather events, such as heavy rainfall. The research identifies key informal financing practices such as borrowing from friends and families and obtaining loans from local money lenders during the times of climate change impacts. These methods are employed to manage immediate financial needs, support day-to-day fish processing operations, and recover from losses due to climate impacts. However, Among these, community-based savings groups (Settu /chit) and loans or savings facilities issued from community-based organizations are highlighted as the most effective methods due to their structured support and long-term stability. The findings revealed that while informal financing offers flexibility and immediate access to funds, it often comes with high interest rates and limited financial security. The reliance on informal sources also underscores the gaps in formal financial services for these women. The study highlights the critical role of informal financing in the resilience of small scale female fish processors, yet it also points to the need for more sustainable solutions. Recommendations include enhancing access to formal financial services, improving financial literacy, and strengthening the community-based financial support systems. Integrating these informal mechanisms into broader climate adaptation strategies can improve the financial stability and resilience of small-scale fisheries communities in Sri Lanka.

Keywords: Climate Change; Gender; Informal Financing; Small-scale Fisheries; Sri Lanka

ICSBE24_282

REMOTE SENSING IN FOREST FUEL ESTIMATION: A SYSTEMATIC REVIEW OF TECHNIQUES, TRENDS, AND LIMITATIONS

W.W.M.S.G. Wanigasundara*, S.R.W.M.C.H. Wanninayake, G.Y. Jayasinghe
Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Kamburupitiya, Sri Lanka
**Correspondence E-mail: sadeesha.wanigasundara@gmail.com, TP: +94773698040*

Abstract: Wildfires are complex processes, the behaviour of which heavily depends on numerous characteristics of fuel, so it is necessitate scientific approaches to predict and manage fire behaviour effectively. Fuel characteristics are essential in analysing as well as fire behaviour regulation but there exists a research question on how these technologies obtain numerous features of forest fuel. This work thus seeks to provide a meta-synthesis of remote sensing studies on forest fuels and issues concerning how well the remote sensing techniques correspond with these fuel characteristics alongside the opportunities and challenges of these techniques. This systematic literature review was done following the PRISMA guidelines and included the articles, which were published between 2008 to 2023 in English languages, retrieved from Google Scholar, IEEE & Springer databases. The articles were searched using certain key words they include Fuel attributes, Forest fuel, Remote sensing, Forest fires and Fuel mapping. First, 121 articles were found in the current literature. Based on these criteria, 96 papers were ultimately considered for the review process. The research showed that most papers centre on the description of over storey fuel characteristics while under storey, bark and surface fuel properties that contribute to fire behaviour are less considered. More specifically, out of the above explained key issues in the fuel characterization, the two most explored areas have been fuel overstorey (47 %) and fuel model (31 %) followed by the understorey fuel (30 %), live and dead fuel moisture (17 %), surface fuel (18 %) and bark fuel (2 %). This means that the current objectives of remote sensing studies do not encompass the forest fuel characteristics essential for fire modelling. Future work should compare fuel properties from the viewpoint of fire behaviour instead of the behaviour models in order to enhance the realism and usefulness of remote sensing for various spatial, temporal and cross-disciplinary settings.

Keywords: Biophysical Modelling; Fire Management; Forest Fires; Forest Fuel Estimation; Fuel Attributes; Remote Sensing

ICSBE24_283

MODELLING SOIL EROSION WITH SWAT: A SYSTEMIC REVIEW OF PROCESSES, CHALLENGES, AND FUTURE ENHANCEMENTS

S.N.N. Senadheera*, T.A.N.T. Perera, H.M.S.K. Herath
Department of Export Agriculture, Faculty of Animal Science & Export Agriculture, Uva Wellassa University, Passara Road, 90 000 Badulla, Sri Lanka
**Correspondence E-mail: nuwanthanayanajith99@gmail.com, TP: +94760538322*

Abstract: Soil erosion caused by water and sediment in river systems significantly impacts to soil health, food security, environmental pollution, reservoir lifespan, and other ecosystem activities. Soil erosion modelling is a crucial step in determining erosion hotspots and planning effective soil conservation strategies. SWAT is a watershed-scale model that is widely used to simulates soil erosion and surface water quality. It is also a continuous-time hydrological and regionally distributed model that has been used in a variety of geographical locations across the world. The purpose of this systemic review is to (a) investigate existing capabilities of SWAT in modelling soil erosion, (b) identify challenges, and (c) propose future improvements. The systemic review was conducted based on 40 previously published research articles from 2010 to 2024. High frequency keywords (SWAT) and co-word (SWAT in soil erosion) analysis indicate that SWAT model research hotspots include water quality issues, sediment yield, model calibration, uncertainty analysis, and sensitivity analysis. The SWAT literature was classified into three categories: model uses in soil erosion modelling, SWAT modelling challenges, and future advancements. Recent studies indicate that SWAT can simulate soil erosion over wide regions. However, setting SWAT for large systems can be challenging due to limitations in input data availability and resolution, as well as concerns with reservoir and impoundment configuration, which can affect streamflow and limit measured data. The study pointed out certain existing issues, prospected future developments, and proposed a research proposal for model enhancement to adapt to domestic changing scenarios. This study should assist in comprehensively understanding the structure, principle, application in soil erosion modelling, and future development trends of the SWAT model, and thereby providing references for SWAT model users in relevant fields.

Keywords: Hydrological Model; Sedimentation; Soil and Water Assessment Tool; Soil Erosion

ICSBE24_287

EXPLORING THE ADAPTATION STRATEGIES TO CLIMATE CHANGE: INSIGHTS FROM A QUALITATIVE STUDY OF SMALLHOLDER FARMERS' PERCEPTION TO CLIMATE CHANGE IN BALANGODA DIVISIONAL SECRETARIAT AREA, SABARAGAMUWA PROVINCE, SRI LANKA

N.P. Kuruppu*, P.K.D.H.S. Alahakoon, K.W.R. Himara, U.B.E. Sasanka
Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
**Correspondence E-mail: npkuruppu@std.agri.sab.ac.lk, TP: +94762806415*

Abstract: Climate change poses severe and far-reaching threats to the environment, human health, global economies, and societal stability. Climate-related risks significantly affect the traditional agricultural practices of smallholder farmers leading to crop yield decline. A survey was conducted from 22 smallholder farmers in the Balangoda area through convenient sampling gathering data via in-depth interviews. Based on the perceptions of farmers, several insights can be gained towards climate-adaptive and climate-resilient strategies that can be adopted. Majority (59 %) of the farmers are not satisfied with the income from agricultural activities, while certain farmers are satisfied (18.2 %) and some remain uncertain (22.8 %) about their income. Other than the many reasons contributing for farmers' dissatisfaction which include financial issues, lack of inputs due to limited government support and limited labour which were worsen with the Covid 19 outbreak, climate related risks remain to be one of the most significant. All farmers (100 %) assessed from the survey have experienced at least a minute impact of climate change in recent years, with almost all farmers experiencing frequent climate-related events changes in rainfall, temperature and wind condition. Droughts, excessive rainfall, floods, landslides were among the major hazards that were faced by the small holder farmer's leading to excessive temperature, deterioration in soil quality and water scarcity significantly impacting the crop yield reduction. Small holder farmers have faced an overall decline in their status of livelihood due to the income insufficiency upon agricultural activities due to perceived risks of climate change. As climate-adaptive practices adjusting planting dates, water management, soil conservation and crop selection techniques were employed by farmers with all farmers (100 %) assessed, currently using at least one practice to adapt climate change. All farmers assessed (100 %) having a specific interest in shifting to climate-resilient strategies highlights the unique requirement of increasing financial support, government subsidies, awareness sessions, and access to technology and resistant varieties for smallholder farmers.

Keywords: Climate-adaptive; Climate-resilient Strategies; Climate Change; Smallholder Farmers; Sri Lanka

ICSBE24_194

URBAN HEAT ISLAND (UHI) IMPACT ASSESSMENT USING SPATIAL AND TEMPORAL DATA TO DEVELOP GREEN URBAN PLANNING STRATEGIES IN COLOMBO DISTRICT

L.A.W.A.C. Liyanage[1*], R.M.A. Dilini[1], R. Amarasingha[2]
[1]Department of Environmental Technology, Sri Lanka Technological Campus, Sri Lanka
[2]Department of Agricultural Technology, Sri Lanka Technological Campus, Sri Lanka
**Correspondence E-mail: liyanagel@sltc.ac.lk, TP: +94784781600*

Abstract: Urban Heat Island's (UHI) impact appears significantly warmer than that of its surrounding rural areas because of land use and surface temperature due to anthropogenic activities. The UHI effect results in negative social, economic, and environmental impacts. It provides a better understanding of the impact of land use and land cover change on surface temperature and necessary mitigation measures to improve urban planning and manage public health issues. This study analyzes distance - and point-based analyses to investigate the influence of the buildup surface, water bodies, and green cover on surface temperature. Direction-based analysis was conducted at the mid-latitude points in the Seethawaka and Colombo Divisional sectarian areas in Colombo District, Sri Lanka. The results of the study confirm that the highest temperature records are in the highest urbanized areas of both study sites. Pearson correlation was used to explore the spatial correlation between the surface temperature, Normalized Difference Vegetation Indexes (NDVI), Normalized Difference Water Indexes (NDWI), and Normalized Difference Built-up Indexes (NDBI). A negative correlation between the surface temperature and NDVI` (-0.430), NDBI (0.339), and NDWI (0.623) has a positive correlation with the surface temperature in Seethawaka. A negative correlation between the surface temperature and NDWI (-0.543), NDBI (0.617), and NDVI (0.330) has a positive correlation with the surface temperature in Colombo. The highest concentration of water bodies mitigates surface temperature, and green areas play a crucial part in reducing UHI. An increase of evenly distributed green areas and waterbodies in urban areas is suggested for low surface temperature and UHI mitigation to sustainable urban development.

Keywords: Urban Heat Islands; Satellite Imagery; Surface Temperature; NDVI; NDWI; NDBI

ICSBE24_500

IMPACT OF ELEVATED ATMOSPHERIC CARBON DIOXIDE AND TEMPERATURE ON PHYSIOLOGY AND GROWTH OF SUGARCANE (*Saccharum hybrid* L.)

K.D.P. Sanka[1], K.B. Madhushani[2*], K.C. Kaushalya[1], A.D. Ampitiyawatta[1], A.L.C. De Silva[3]

[1]Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
[2]Faculty of Graduate Studies,University of Ruhuna
[3]Sugarcane Research Institute, Udawalawe
**Correspondence E-mail: stcmadushanik@gmail.com, TP: +94713848103*

Abstract: Atmospheric carbon dioxide concentration (CO_2) and air temperature are raising simultaneously. Hence the increasing (CO_2) is recognized as a foremost contributor of global climate change due to greenhouse effect. Therefore, the productivity of crops is susceptible to the direct effects of climate change and the reduction of it universally predicted in most standing reports. Also, future climate change is expected to have impacts on extend and the productivity of sugarcane. A study was conducted to investigate the agronomic and physiological performances of different sugarcane varieties under elevated atmospheric (CO_2) and temperature expected in the future at SRI, Udawalawe. A split-plot design was used with five main treatments in main-plots and eight sugarcane (*Saccharum hybrid* L) varieties (Co 775, SL 7130, SL 8306, SL 88116, SL 906237, SL 924918, SL 96128 and SL 96328) in sub-plots as sub treatments under well-watered conditions. Main treatments were ambient (CO_2) with ambient temperature (CATA), ambient (CO_2) with elevated temperature (CATE), elevated (CO_2) with ambient temperature (CETA), elevated (CO_2) with elevated temperature (CETE) and open field control treatment. Levels of ambient (CO_2), elevated (CO_2), ambient and elevated temperature were 400ppm, 665 ppm 34˚C and 37˚C, respectively. Micro climatic conditions in the experimental plots, growth measurements and physiological measurements were taken from 4 to 7 Months After Planting (MAP). The results revealed that elevation of air temperature increased the leaf temperature and transpiration rate (E). The response of elevation of air (CO_2) was positive on the growth and biomass accumulation of sugarcane whereas it was negative on the stomatal conductance (gs) and transpiration rate (E) of sugarcane and also it was variable on leaf photosynthetic rate (A) and Instantaneous Water Use Efficiency (IWUE). The combined effect of elevation of air (CO_2) and temperature (CETE) was highly variable on growth and gas exchange parameters of sugarcane.

Keywords: Climate Change; Elevated (CO_2); Elevated Temperature; Sugarcane

ICSBE24_488

A GIS-BASED IMPACT EVALUATION ON URBAN SUSTAINABILITY: A CASE STUDY OF KUBICHCHANKULAMA GREEN SPACE IN ANURADHAPURA NEW CITY, SRI LANKA

R.M. Fernando[1*], W.S. Indumini[1], P.G.T. Poornika[1], M.W.T.K. Munasinghe[1], S. Maduwanthi[1], N.G.K.L.C. Kumara[2]

[1]Department of Geography, Faculty of Arts, University of Peradeniya
[2]Faculty of Natural Sciences, The Open University of Srilanka
**Correspondence E-mail: a18gis010@arts.pdn.ac.lk, TP: +94728643641*

Abstract: According to the United Nations Department of Economic and Social Affairs (UN DESA), urbanization now covers more than half of the world's population. This causes the extreme climatic conditions and biodiversity loss. Addressing these challenges requires sustainable development and land adaptation policies. This study explores the role of green spaces in promoting urban sustainability, focusing on the New Town area of Anuradhapura, Sri Lanka. Examines green space expansion, climate impact, and urban sustainability, particularly around the Kumbichankulama Lake. This study used a multi-step methodology including GIS techniques. First, have to digitize city boundaries, green spaces, and calculation of their areas. Furthermore, supervised classifications were used to analyze land use between 2015 and 2023. Additionally, NDBI was calculated to identify areas with high building density. Moreover, analyze Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) changes between 2013 and 2023. For SWOT analysis, we conducted interviews with stakeholders and field observations. The findings revealed that small gardens are the most common than regional and community gardens. These green spaces are well distributed throughout the city. It reflects urban accessibility and promotes a balanced integration of nature within residential and commercial areas. And the city experienced significant land use changes between 2015 and 2023. Increase in built-up area and decrease in vegetation cover, especially around Kubicchankulama Lake. These changes highlight the rapid urbanization of the region. Also, from 2015 to 2023, there is an increase in land surface temperature. Also, NDVI analysis revealed a significant reduction in vegetation due to rapid infrastructure development. Furthermore, SWOT analysis identified strengths such as reducing urban heat, improving environmental beauty, and promoting physical and mental well-being. As the weakness, lack of essential facilities, environmental pollution, ethical concerns, and inadequate maintenance inhibit its potential. Economic development through tourism created employment opportunities for local residents. Maximum benefits can be achieved through strategic planning and collaboration. It will be useful for locals and visitors. Finally, this study revealed the importance of green space in urban planning. By integrating nature with urban development, cities can improve environmental quality and promote physical and mental health.

Keywords: Urbanization; Green Spaces; Sustainability; GIS-based Analysis

ICSBE24_020

URBAN GROWTH MODELING AND CLIMATE VULNERABILITY IN THE COLOMBO METROPOLITAN AREA

H.P.U. Fonseka[1,2*], S.P. Chaminda[1], H. Zhang[3], R. Premasiri[1]
[1]Department of Earth Resource Engineering, Faculty of Engineering, University of Moratuwa
[2]Arthur C Clarke Institute for Modern Technologies, Sri Lanka
[3]Department of Geography, The University of Hong Kong
**Correspondence E-mail: panchali.u.fonseka@gmail.com, TP: +94710737827*

Abstract: This paper focuses on the urban growth modelling of the Colombo Metropolitan Area (CMA), employing Artificial Neural Networks (ANNs) and Cellular Automata (CA). In modelling urban growth, many influencing factors were utilized, including social, economic, and environmental aspects. The results indicate that urban expansion has increased from 2007 to 2037. The simulation expects a steady increase in urban development, with corresponding declines in native vegetation and other natural land covers. As an urban metropolitan area, its climate vulnerability is examined using downscaled models under both RCP 4.5 and RCP 8.5 scenarios. Key findings suggest that the CMA will face heightened risks of flooding and heatwaves, necessitating robust policy interventions and land management strategies to mitigate these effects. The study emphasizes the urgency of adopting sustainable urban planning practices that are aware of present and future climate conditions, aiming to safeguard and enhance the resilience of urban ecosystems and communities against impending climate change.

Keywords: Urban Growth; Climate Vulnerability; Colombo Metropolitan Area; Artificial Neural Networks; Cellular Automata; Remote Sensing; Landsat Imagery

ICSBE24_100

USE OF GAMIFICATION AND SERIOUS GAMES FOR DISASTER EDUCATION; PRACTICES, TRENDS AND WAY FORWARD

R. Mahamood[1*], C.K. De Silva[1], N. Kankanamge[2], D. Ranasinghe[1], N. Kangana[1]
[1]*University of Moratuwa, Katubedda, Moratuwa, Sri Lanka.*
[2]*University of Sunshine Coast, Queensland, Australia*
**Correspondence E-mail: mahamoodrifat97@gmail.com, TP: +94778346251*

Abstract: Disasters have a substantial worldwide influence, which is worsened by a continuously increasing population, requiring effective disaster preparedness and mitigation strategies. It is crucial to ensure that communities and governments are watchful, responsive, flexible, and well-informed. Researchers, experts, and individuals responsible for managing disasters are always exploring novel strategies to improve community readiness for upcoming difficulties. One innovative method is the implementation of gamification, which has been utilised in other domains, such as disaster management, to enhance education and practical experience. This study examines the use of gamification and serious games in the context of disaster preparedness and mitigation. An extensive evaluation of 72 serious games, encompassing board games, dice games, and digital media, was undertaken. The identification of these games was based on published journal studies, game reports, and empirical play. The analysis indicated that 38 % of the games prioritise the response phase of the disaster management cycle, while 25 % concentrate on the preparedness and mitigation phases. The study examines the knowledge and logical reasoning incorporated in these games to enhance public understanding of the significance of disaster preparedness and mitigation. Evidence suggests that board games are generally less informative than digital games, as digital games make use of spatial configurations, which are a critical element in disaster preparedness and mitigation. The study also offers insights into the application of gamification-generated awareness to sustainable built environment practices. Furthermore, it emphasises crucial factors that scholars should take into account while creating future serious games. The novelty of this study lies in its focus on developing a gamified application specifically designed for children and youth, addressing the spatial dimension of disaster preparedness, which has often been overlooked in previous games. This innovative approach enhances the understanding of how geographic and location-specific factors influence disaster outcomes and mitigation efforts. It also provides ideas for optimising game design to effectively educate and prepare populations. This paper adds to the continuing discussion on novel techniques for managing disasters and highlights the need of using gamification to promote a resilient and well-prepared society.

Keywords: Gamification; Serious Games; Disaster Preparedness; Disaster Mitigation; Sustainable Practice

ICSBE24_095

REMOTE SENSING ANALYSIS OF FOREST FIRE DYNAMICS: A CASE STUDY OF THE HANTHANA MOUNTAIN RANGE, KANDY, SRI LANKA

W.M.S.S. Dias*, W.B.M.R.S. Basnayaka
University of Peradeniya, Peradeniya, Sri Lanka
Correspondence E-mail: mihirdias@gmail.com, TP: +94779414936

Abstract: The Hanthana Mountain Range in Kandy, Sri Lanka, holds significant ecological, scientific, and recreational value. Despite being designated as a Hanthana Environmental Protection Area (HEPA) in 2010, the region has been subject to frequent seasonal forest fires. Traditional field assessments have struggled to quantify this damage accurately. Therefore, this study employs Remote Sensing (RS) and Geographic Information System (GIS) to assess forest fire damage, burn severity, and underlying causes from 2014 to 2024 in Hanthana. The HEPA spans 38.56 km² across the Gangawata Korale, Doluwa, Pathahewaheta, and Delthota divisional secretariats in the Kandy District. Fire incident data were collected from the NASA Fire Information for Resource Management System (FIRMS) alongside ten C2L2 Landsat 8 satellite images of 2014, 2016, 2019, 2022, and 2024 to analyse Normalised Burn Ratio (NBR) and Normalised Difference Vegetation Index (NDVI). Differenced NBR (dNBR) was employed to assess varying levels of burn severity, and land cover maps were created using Interactive Supervised Classification, validated with historical Google Earth imagery. Further, terrain analysis was conducted to determine the impact of slope and elevation on fire occurrence. Additionally, average monthly rainfall data, Central Environmental Authority (CEA) records, previous research, interviews and news reports were used to identify the causes of the fires. Findings reveal that Mana Grassland, Pinus, and Eucalyptus areas are the most affected by frequent fires, particularly in February and March which correlate with the driest period in Hanthana. The dNBR analysis indicated that burn severity varies from low to moderate levels at elevations between 600 m and 900 m, and above 1000 m along the eastern ridges, which show moderate to high slope gradients. Human-induced fires, particularly for hunting, were identified as a significant cause. Therefore, integrating RS and GIS to analyse forest fire dynamics is crucial for assessing and mitigating them in the Hanthana Mountain Range.

Keywords: Forest Fires; Geographic Information System; Hanthana; Normalised Burn Ratio; Remote Sensing

ICSBE24_088

WATER MANAGEMENT ADVISORIES TO IMPROVE WATER USE EFFICIENCY IN THE VILLAGE IRRIGATION TANKS IN SRI LANKA

W.I.U. Warnakulasooriya[1*], E.I.E. Sulochana[2], M.M. Liyanage[2]
[1]Sri Lanka Red Cross Society, Climate Resilient Integrated Water Management Project
[2]United Nations Development Programme, Climate Resilient Integrated Water Management Project
**Correspondence E-mail: ujithawarnakulasooriya@gmail.com, TP: +94716037663*

Abstract: One of the major challenges facing modern human civilization is climate change. This study documents the lessons learned from improving water management and producing advisories to improve water use efficiency in village irrigation tanks in selected cascades in the Dry Zone of Sri Lanka. Primary data for the study were obtained from the farmers and farmer organizations, village irrigation systems in the Palugaswewa, Mamunugama, and Medde Rambewa Cascades in Anuradhapura, Kurunegala, and Puttalam districts, respectively. The irrigation systems were equipped with water depth gauges in the tanks and rain gauges in the command area, and daily readings were taken by the farmers. Actual water use was estimated by using these readings and long-term averages of evaporation while approximating seepage and percolation losses in a spreadsheet water balance model. The daily water balance was also used to identify recording errors. A methodology to calculate the cultivable area using tank storage, forecasted rainfall, and long-term evaporation losses were also developed. The water management advisories produced from this information included, cultivable area reference to water availability, water use efficiency in the respective tanks, measures to improve data recording, irrigation duty, and measures to optimize the cultivable area each season. The results show that irrigation duty in *Yala* season ranged from 3.40 to 4.70 acre-feet/acre, while it ranged from 2.35 to 3.55 acre-feet/acre in the *Maha* season. However, the results of the study have confirmed that the efficiency of water use in many lakes during the dry season *(Yala)* is very low, and for this reason, it is appropriate to provide water management advisories. The study recommends the distribution of water on regular irrigation interval, the alternating wetting and drying method, having drought-resistant and short-term crops and varieties, parachute farming, inception land preparation with rain, promoting collectivism method of managing common pool resources rather than individualism, using the appropriate adaptation strategies for dissemination of agro-met advisories and weather forecast ground level and capacity building of farmer organizations and monitoring hydrological data.

Keywords: Cascade Systems; Irrigation; Village Tanks; Water Management Advisories; Water Use Efficiency

ICSBE24_144

THERMO MECHANICAL ANALYSIS OF ANCIENT STUPAS IN SRI LANKA

D.D.H.K. Kulasiri, K.A.T.D. Perera, I.U.K. Silva, P.A.K. Karunananda
Department of Civil Engineering, The Open University of Sri Lanka, Nawala, Sri Lanka
Correspondence E-mail: dayaniharsha123@gmail.com, TP: +94743783160

Abstract: The effect of temperature variation has not been adequately addressed in the stress analysis of ancient stupas. However thermal loading is a significant contributor among the stresses acting on the stupa shell. This paper discusses the behaviour of one of the ancient stupas: *Jethawana* stupa under thermal loadings. Evaluation of properties of the stupa restoration brick such as water absorption and compressive strength were evaluated with adequate laboratory testing. Test results indicated that the restoration brick of the *Jethawana* stupa which was made akin to the original ancient stupa has higher quality than the modern bricks. Two-dimensional finite element model analysis using SAP2000 general purpose software package, was carried out to assess the stresses developed in the stupa surface due to the thermal loading effect. The said model analysis was conducted for five separate temperature load cases considering stress and deformation under thermal loading. The results showed that the compressive stresses had developed on the surface of the stupa than towards the core of stupa. Further, the stresses due to the thermal loading on the surface of the existing stupa were significantly higher at the juncture where the dome and the square chamber meet. When comparing the contrasting difference between the colour contours at the said location, it is evident that the result is significant. Even though the abnormal result does not lead to conclude that there is a definite impact of thermal stress on the existing restoration works, the study suggests that it could be taken as a notable point to do further analysis on the same area of study.

Keywords: Restoration Works; Thermal Loading; Thermal Stress; Finite Element Modelling; Two-dimensional; Colour Contours

ICSBE24_281

INTEGRATING CLOUD TECHNOLOGY AND REMOTE SENSING FOR SPATIAL FLOOD ANALYSIS IN MATARA DISTRICT, SRI LANKA

M.M.A.D. Munasinghe[1*], H.A.C. Priyankara[2], G.Y. Jayasinghe[1]
[1]*Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Matara, 81100, Sri Lanka*
[2]*Department of Bio-Systems Technology, Faculty of Technology, University of Ruhuna, Matara, 81100, Sri Lanka*
**Correspondence E-mail: munasinghe24gt@ags.ruh.ac.lk, TP: +94717724787*

Abstract: Floods are one of the most destructive natural disasters, which are caused by climate change and affect both human beings as well as the environment globally. Cloud-based remote sensing technologies provide reliable tools for identifying, assessing, and controlling floods when using high-resolution satellite imagery. The use of Sentinel-1 Synthetic Aperture Radar (SAR) images has been widely applied in previous studies for the visualization of floods and the assessment of flood damage, as an advanced, feasible, reliable, and efficient method. This study aimed to identify highly flood-affected areas using change detection approach technique algorithms on Google Earth Engine (GEE) by assessing a series of floods in Matara District, Sri Lanka from 2016-2024. In the methodology, flood images were acquired after applying preprocessing, mosaicking, speckle smoothing, and thresholding steps for the Sentinel-1 SAR image collection. The results showed the vast flood-affected years as 2017, 2023, and 2024, and the worst flood event was identified in 2017 May. 6.16% of the land area of Matara district was affected by floods during the study period. Highly flood-affected areas were identified and most (25.4%) are located in the Thihagoda divisional secretariate. This study demonstrated the effectiveness of applying advanced cloud-based remote sensing techniques to flood disaster management. The results will guide an effective flood management strategy including improved drainage planning and urban resilience. The study could be expanded by using satellite remote sensing and weather station data to analyze precipitation data in specific locations.

Keywords: Flood Change Detection; Flood Management; Google Earth Engine; Sentinel-1; Synthetic Aperture Radar (SAR)

ICSBE24_285

APPLICATION OF THE VEGETATION HEALTH INDEX (VHI) TO ASSESS THE DROUGHT CONDITIONS DURING DRY SEASON IN PADAVIYA DIVISIONAL SECRETARIATE DIVISION IN ANURADHAPURA DISTRICT

W.K.S. Prarthana*, A.K. Wickramasooriya
Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: 19gis044@arts.pdn.ac.lk, TP: +94773395897*

Abstract: The Vegetation Health Index (VHI) plays a critical role in monitoring the status of droughts. It quantifies the severity of drought-induced stress on vegetation. The VHI can be derived using the Normalized Difference Vegetation Index (NDVI), which reflects the vegetation greenness, and the Land Surface Temperature (LST), which captures the heat of the land surface. In this study Padaviya Divisional Secretariat Division in the Anuradhapura District which is located in the Dry Zone of Sri Lanka has selected as the study area. The research focused on assessing the drought severity and understanding the VHI based on the influence of NDVI and LST, particularly during the dry season in 2016 and 2023. According to climate data obtained from NASA power web portal, the period from May to August which recorded the lowest precipitation levels and also recorded the highest incidence of droughts in both years in Padaviya. Therefore, cloud free Landsat 8 and Landsat 9 satellite images of the month of August in 2016 and 2023 are used to analyze VHI. The evaluation of drought severity was accomplished by calculating VHI, while correlation analyses were carried out between NDVI and VHI and LST and VHI. The findings revealed that the VHI has decreased from 20 % to 13 % in 2016 to 2023 indicating that the severity of drought increased in 2023 compared to 2016. According to the correlation between NDVI and VHI in 2016 and 2023 were recorded as 0.56 and 0.64 respectively. This is an indicator of there is a good relationship between vegetation greenness on vegetation health. However, the results of the correlation analysis between LST-VHI showed that there is a negative weak correlation i.e. -0.37 and -0.48 in 2016 and 2023 respectively indicating there is less influence of land surface temperature on vegetation health. Therefore, it can be concluded that the droughts are more sensitive to status of vegetation and other pertinent environmental factors rather than land surface temperature.

Keywords: VHI; NDVI; LST; Drought Severity; Correlation

ICSBE24_280

EFFECT OF URBAN PARK CHARACTERISTICS ON PARK COOL ISLAND INTENSITY IN COLOMBO URBAN AREA; OPTIMIZATION OF SUSTAINABLE URBAN PARK PLANNING

A.A.S.G. Wijesundara, B.G.N. Sewwandi*
Department of Zoology and Environmental Management, Faculty of Science, Univeristy of Kelaniya, Dalugama, Kelaniya
**Correspondence E-mail: sewwandidh@kln.ac.lk, TP: +94112914479*

Abstract: Colombo is a rapidly urbanizing hub where Urban Heat Island (UHI) effect has become serious with the growth of urban areas and the global climate change. The urban parks that exist in an urbanized area play a crucial role to mitigate the UHI effect and regulate the climate by their potential ability known as the Park Cool Island (PCI), to create cool microclimates. The difference between the air temperature inside the park and the surrounding urban area is described as the PCI intensity. The selected urban parks in Colombo urban area exhibit an average cooling effect of 0.98 °C proving the PCI phenomenon. Through a vigorous study of field-based data collection, satellite imagery, and utilization of Pearson's correlation and regression analysis, it is found that the PCI intensity has a significant relationship with the park characteristics such as park layout, park vegetation structure and the park composition. The analysis found that the park area has the most significant positive relationship with PCI intensity following the park perimeter as well. Apart from that, the park shape also plays a crucial role in maximizing the cooling effect. The cooling effect within parks is significantly influenced by the characteristics of vegetation, with canopy density being a key determinant. Particularly, a canopy density exceeding 80 % notably amplifies the PCI by more than 1.0° C. Furthermore, other vegetation features such as tree basal area, tree height, diameter at breast height, and stem density demonstrate a substantial positive correlation with PCI intensity, following canopy density in a descending order. Furthermore, park composition analysis reveals that higher water and green cover contribute to maximizing PCI intensity, underscoring the importance of reducing impervious cover in urban park design. The findings of this research provide valuable insights for urban planners, facilitating the development of more effective urban park designs aimed at maximizing cooling effects and promoting sustainable urban development in the face of climate change.

Keywords: Urban parks; Urban Heat Island (UHI); Park Cool Island (PCI); Climate Change; Sustainable Urban Planning

ICSBE24_470

ASSESSMENT ON CARBON SEQUESTRATION PERFORMANCE OF ROADSIDE TREES IN BATTICALOA REGION, SRI LANKA

S.M.M. Hazeema, B.G.N. Sewwandi*
Department of Zoology and Environmental Management, Faculty of Science, University of Kelaniya
**Correspondence E-mail: sewwandidh@kln.ac.lk, TP: +94112914479*

Abstract: Roadside trees significantly reduce ambient temperature, heat island effects, and rainwater runoff, contributing to climate change mitigation by reducing CO_2 and suspended particulate matter. This research aims to assess the carbon sequestration potential of various roadside tree species to identify the best carbon sequestering tree species on the main road of the selected DSD areas in the Batticaloa region. A total of 7 strip plots were established systematically for the detailed carbon assessment and 95 different matured native and introduced tree species were recorded on the roadsides of the main road. The Total biomass of each tree species was considered in the detailed assessment. Above Ground Biomass (AGB) was calculated using measurable parameters such as Diameter at Breast Height (DBH) and total tree height. Wood density was determined using laboratory experiments. The relationship of AGB with DBH and Tree height was compared. Variations of total biomass between different diameter classes were compared. Total CO_2 absorbed by each tree species was obtained using standard equations to identify the best carbon-sequestering tree species. However, total biomass between different DSD areas on the roadsides of main road was compared to determine urban green space changes in the study area. The highest total biomass observed in tree species such as *Samanea saman* and *Phoenix dactylifera* were about 9231 ± 2050 and 2882 ± 156 tCO_2e, which reflect native and introduced tree species respectively. The highest CO_2 was stored in Kallady DSD area than in other areas and a strong relationship between AGB and DBH was observed through scatterplots. These findings could inform policymakers about the effectiveness of trees in balancing or offsetting CO_2 emissions and determining the necessary trees to offset net CO_2 emissions.

Keywords: Carbon Sequestration; Roadside Trees; AGB

ICSBE24_799

LICHEN AS A BIOMONITOR TO MONITOR INDUSTRIAL POLLUTION IN TWO SELECTED INDUSTRIAL ZONES IN SRI LANKA

A.R.T.M. Gunarathna*, A.D.S.N.P. Athukorala
Department of Botany, Faculty of Science, University of Peradeniya, 20400
**Correspondence E-mail: s18040@sci.pdn.ac.lk, TP: +94763513621*

Abstract: Industrial air pollution poses significant environmental concern that releasing various pollutants, including Sulfur dioxide (SO_2), Nitrogen oxides (NOx), heavy metals, volatile organic compounds, and particulate matter into the air, leading to adverse effects on ecosystems, human health, and biodiversity. Lichens are sensitive bio-monitors for measuring industrial pollution, as they effectively capture and accumulate air-borne contaminants, reflecting the extent of air quality. This study investigated the impact of industrial air pollution on epiphytic lichens, using them as bio-monitors across two industrial sites: Site A (cement industry) and Site B (industrial state with 45 industries), along with corresponding two reference sites characterized by similar vegetation. Lichen sampling was conducted on 30 randomly selected, free-standing trees, where species diversity, abundance, and pollution levels were quantified using Shannon-Wiener and Simpson indices. Results indicated a lower Shannon Index (HA = 1.06972), Simpson index (DA = 0.513032) and abundance (1239) at Site A compared to its reference site in a less industrialized area (Ha = 1.1069, Da = 0.593215, 1300). Notably, species richness (7) is similar in both Site A and its reference site. Site B exhibited a Shannon Index of 2.42802 with an abundance of 1262 and 13 species richness , while its reference site yielded higher diversity (Hb = 2.47545), abundance (1997) and richness (22). These findings suggest that an industrial activity significantly had influenced lichen diversity and abundance in relevant sites. Additionally, *in-vivo* transplanting experiment and *in-vitro* stimulating experiments are on-going to evaluate the responses to air quality changes to further understand the impacts of industrial pollutants on lichens thereby the environment. This study underscores the value of biological indicators, like lichens, in environmental monitoring and will highlight the need of sustainable industrial practices towards mitigating pollution effects.

Keywords: Industrial Air Pollution; Epiphytic Lichens; Environmental Monitoring; Sustainable Practices

ICSBE24_010

A REVIEW OF THE IMPACT, VULNERABILITY, AND ADAPTABILITY OF CLIMATE VARIABILITY

S.M.N.S. Senanayaka*, E.M.S. Ranasinghe
Department of Geography, Faculty of Arts, University of Colombo, Sri Lanka
**Correspondence E-mail: nisansalasenanayaka18@gmail.com, TP: +94710152357*

Abstract: Climate variability is the short-term climate changes that take place over months, seasons, and years and its impacts are differently distributed among different regions, generations, age classes, income groups, occupations, and genders. Accordingly, the study aimed to review the impact, vulnerability, and adaptability of climate variability. Hence, the objectives of the study were to identify the impact aspects of climate variability, to analyze the vulnerability of climate variability, and to recognize the adaptation strategies adopted for controlling the impact of climate variability. Based on the selected articles, it has been confirmed that numerous studies have been carried out in various parts of the globe concerning climate variability. However, the majority of these studies focused on the African region. After analyzing research articles, various aspects of climate variability were found to have significant impacts. These include agriculture and food security, tourism, human health, mortality, poverty, infrastructure, disasters, water resources, and wildlife resources. Among them, agricultural production and food security are directly influenced by climate variability, and numerous studies have studied it. Climate variability impacts men and women differently due to differences in their traditional roles, societal expectations, and livelihoods. Further, several studies have found that women are more vulnerable to the negative impacts of climate variability than men due to socioeconomic structures and norms. It was also confirmed that small farmers in developing countries are highly vulnerable to climate variability. Climate variability adaptation strategies are implemented at varying scales in different countries such as at the farmer level, at the local level, and at the international level. In developing countries, farmers and women have less adaptive capacity to adapt to climate variability. Meanwhile, poor adaptive capacity, unresponsive governments, lack of credit, household income, and weak policy mechanisms are barriers to adaptation. Therefore, mitigating the impacts of climate variability must be of the utmost importance. While there is no single solution to climate change, however, there is a need to integrate methods of adaptation with modern and environmental-friendly technologies.

Keywords: Adaptability; Climate variability; Global; Impact; Sri Lanka; Vulnerability

ICSBE24_286

SPATIAL PATTERNS OF PM 2.5 AND PM 10 AIR POLLUTION IN COLOMBO MUNICIPAL COUNCIL AREA

O.K.T.N. Dananjana[1], B.L.W.K. Balasooriya[1], U.W.A. Vitharana[2]
[1]Department of Biotechnology, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka Makandura, Gonawila (NWP), 60170, Sri Lanka
[2]Department of Soil Science, Faculty of Agriculture, University of Peradeniya, 20400, Sri Lanka
**Correspondence E-mail: wajirab@wyb.ac.lk, TP: +94719367648*

Abstract: Air pollution is closely linked to economic expansion and rapid urbanization. The economic capital of Sri Lanka, Colombo, is densely constructed and populated, causing challenges of urban air pollution. This growing problem has become a focal point of concern due to its extensive and detrimental impacts on the health of living organisms and ecosystems. This research aimed to determine the spatial distribution of air pollutants (PM2.5, PM10) in the Colombo Municipal Council (CMC) area. A systematic grid sampling approach was employed, with 42 sampling points using a fishnet tool. The particulate matter (PM2.5 and PM10) concentrations were measured using a low-cost laser-scattering-based particle concentration sensor from the 28th of February to the 10th of April, 2024. Spatial distribution maps of PM 2.5 and PM 10.0 were developed using the Inverse Distance Weighted (IDW) technique using ArcGIS 10.8 software. The recorded mean values for PM2.5 and PM10.0 were 63.35 ± 37.70 µg/ m^3 and 68.11 ± 38.56 µg/ m^3, respectively. The spatial distribution maps of PM2.5 and PM10 within the CMC area exhibit a distinct spatial pattern, with higher PM values in the Northern and North-Eastern areas and lower PM values in the Southern and South-Western areas. In the high PM zone, the average PM 2.5 (111.57±4.80 µg/ m^3) and PM 10 (117.11±5.41 µg/ m^3) were significantly higher than that in the low PM zone (PM 2.5 39.25±2.64 µg/ m^3) and PM 10 (43.61±2.62 µg/ m^3). Based on the observed average PM 2.5 and PM 10 values, the air pollution level in the high PM zone can be classified as unhealthy according to the air quality standards stipulated by the Central Environmental Authority of Sri Lanka. Further studies are recommended to study the temporal patterns of PM pollution in the CMC area.

Keywords: Colombo; Particulate Matter; Spatial Patterns; Urban Air Pollution

ICSBE24_304

EFFECT OF PACKAGING MATERIALS ON THE QUALITY OF SULPHUR FUMIGATED CEYLON CINNAMON (*Cinnamomum zeylanicum* Blume)

S.P. Kodippili[1], A.A. Wijeweera[2], C.U. Widanapathirana[2], Mapa S.T. Mapa[1*]
[1]Department of Biosystems Technology, Faculty of Technology,
University of Sri Jayewardenepura, Homagama 10206, Sri Lanka
[2]National Cinnamon Research & Training Center, Department of Cinnamon Development,
Palolpitiya 81280, Sri Lanka
**Correspondence E-mail: sumudu.mapa@sjp.ac.lk, TP: +94764121983*

Abstract: Ceylon cinnamon (*Cinnamomum zeylanicum* Blume) quills are miracle spice produced from Sri Lanka that frequently fumigated with Sulphur as a postharvest treatment. Fumigated cinnamons are packed inside different packaging materials by targeting the market. This study aimed to evaluate the quality of fumigated cinnamon packed in commonly used packaging materials with respect to two initial residual Sulphur dioxide (SO_2) statuses approximately 50 ppm and 150 ppm. Twelve kilograms of cut cinnamon were fumigated respectively with 24 g and 42 g doses of Sulphur in a 120 ft^3 chamber for 15 hours to achieve the targeted residual SO_2 levels. Fumigated cinnamon quills were immediately packed in five packaging materials named metalized polyethylene terephthalate (M. PET), polyethylene terephthalate/linear low-density polyethylene (PET/LLDPE), polyethylene terephthalate/aluminum foil/liner low-density polyethylene (PET/AL/LLDPE), polypropylene (PP) and low-density polyethylene (LDPE) with respective thickness of 0.048 ± 0.001, 0.075 ± 0.001, 0.094 ± 0.001, 0.068 ± 0.001 and 0.075 ± 0.001 mm and stored under the ambient condition for nine weeks. Physical, chemical, and biological quality parameters of packed cinnamon were evaluated at three-week intervals. Packaging material had a significant impact on moisture content, water activity, residual SO_2 levels, lightness coordinate (L*), yellowness to blue attributes (b*), and yeast and mold count (YMC) of cinnamon ($p<0.05$). L* and b* values of cinnamon packed in M. PET and PET/AL/LLDPE did not vary significantly during the storage period. However, the residual SO_2 levels in the quills significantly declined over time, with the highest SO_2 residual levels observed in cinnamon packed in PET/AL/LLDPE. The lowest level of YMC was found in cinnamon packed in PET/AL/LLDPE for both residual statuses after nine weeks. PET/AL/LLDPE material showed the highest potential to maintain the best quality of Sulphur fumigated cinnamon and high barrier packaging can control the rate of quality deterioration, though the quality of cinnamon declines with time irrespective to the packaging materials.

Keywords: *Cinnamomum zeylanicum* Blume; Packaging Materials; Sulphur Fumigation; Quality

ICSBE24_273

A PARTICIPATORY COMMUNITY APPROACH TO ENSURE SUSTAINABLE BEEKEEPING PRACTICES AMONG SCHOOL STUDENTS UP COUNTRY, SRI LANKA

E.A.P.A.E. Epa Arachchi[1*], Hasitha Priyashantha[2], Shishanthi Jayarathna[2], J.K. Vidanarachchi[1], M.N. Edirisinghe[1], W.H. Jayasinghe[3]

[1]Department of Animal Science, Faculty of Agriculture, University of Peradeniya
[2]Department of Moleculer Sciences, Swedish University of Agricultural Sciences
[3]Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya
**Correspondence E-mail: pasinduepaarachchi@pdn.ac.lk, TP: +94774921845*

Abstract: This study investigates the effectiveness of a participatory community approach in promoting sustainable beekeeping practices among school students in Up Country, Sri Lanka. The research was conducted in two locations, Meemure and Ududumbara, targeting students from grades 6 to 11 who expressed an interest in beekeeping. Sixty students were selected and organized into 15 groups, with each group receiving two bee boxes, instructional books in Sinhala on basic beekeeping practices, and the necessary equipment. Prior to the distribution of bee colonies, a one-day intensive training was conducted to build the students' capacity on sustainable beekeeping. All bee colonies were in uniform condition at the time of distribution. Student interest and knowledge in beekeeping were assessed using a 5-point scale, where 1 represented low interest/knowledge and 5 indicated the highest. Before the capacity-building session, the average student knowledge was rated at 1.06 (SD 0.71), while interest was rated at 3.60 (SD 0.91). Post-training, both knowledge and interest significantly increased to a satisfactory level. The average interest was 4.96 (SD 0.20) while the knowledge was 4.32 (SD 0.89). Three weeks after the distribution, a post-evaluation was conducted to assess the colonies, considering factors such as level of honey, pollen, eggs, larvae presence, and pest infestations, including Wax Moths. The results revealed that 14.8 % of the bee colonies were attacked by termites, 26.9 % of the colonies were reported which bottom board had not been cleaned. Those reported colonies will be having high chance of getting Wax moth problems. 7.4 % were already invaded by Wax Moths, and another 7.4 % were categorized as weak and at risk of absconding. Despite these challenges, 70.4 % of the colonies met the standard levels, indicating the successful adoption of proper beekeeping practices by the students with strong capacity building under the community approach technique among young learners.

Keywords: Sustainability; Community Beekeeping; Up Country; Sri Lanka

ICSBE24_136

IDENTIFICATION OF MARKET POTENTIAL FOR CARBONATED DRINKS WITH NUTRITIOUS LOCAL GRAINS

K.S. Nawagomuwage[1*], M.L.P. Thathsarani[1], U.A.S.K. Edirisinghe[1], Methmini Tharanga[2]

[1]Department of Agriculture & Food Technology, University of Vocational Technology Ratmalana
[2]Department of Industrial Management, University of Vocational Technology Ratmalana
**Correspondence E-mail: sajaniksn@gmail.com, TP: +94769851160*

Abstract: Carbonated beverages continue to enjoy widespread popularity due to their refreshing qualities. However, the majority of commercially available carbonated drinks are characterized by high sugar content, low nutritional value, and have been linked to the rising prevalence of non-communicable diseases (NCDs). In response to these health concerns and to address protein malnutrition, particularly in children in Sri Lanka, this study investigates the market potential for protein-enriched carbonated beverages utilizing locally sourced, protein-rich ingredients, such as grain extracts. The objective is to develop a cost-effective, nutritionally enhanced alternative while retaining the sensory appeal of traditional carbonated beverages. An online survey was conducted with a sample of 200 randomly selected participants, and the data were analyzed using MINITAB-19 software at a significance level of 0.01. The analysis revealed no statistically significant correlation between gender and preference for carbonated beverages. However, age was identified as a key determinant of consumer preferences, with the 18–25 age group representing the largest market segment. Specifically, 45.5 % of respondents within this demographic expressed a preference for fizzy drinks. In terms of employment status, undergraduates constituted the largest consumer group (37.5 %), followed by part-time and full-time employees (31 %), and students or unemployed individuals (19 %).These findings highlight a consistent demand for carbonated beverages across diverse demographic groups, particularly among younger consumers. The incorporation of locally sourced, protein-rich ingredients offers manufacturers the opportunity to meet consumer demand for refreshing beverages while addressing the need for healthier, more nutritious options. The study concludes that protein-enriched carbonated beverages present significant market potential, providing a healthier alternative to conventional high-sugar drinks while appealing to health-conscious consumers seeking both refreshment and nutritional value.

Keywords: Carbonated Drinks; Market Potential; Local Grains; Nutritious Alternatives; NCD

ICSBE24_305

DEVELOPMENT OF CUCUMBER BASED VALUE ADDED READY TO SERVE BEVERAGE (RTS) ENRICHED WITH NATURAL COLORS

R.M.N.A. Wijewardane[1*], H.P.N.M.A. Herath[2], P.K.J. De Mel[2]
[1]National Institute of Postharvest Management, Jayanthi Mawatha, Anuradhapura, Sri Lanka
[2]Department of Agriculture and Pantation Engeneering, Faculty of Engeneering Technology, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka
**Correspondence E-mail: nilanthiipht@gmail.com, TP: +94715342224*

Abstract: The development of Ready-To-Serve (RTS) beverages with highly perishable vegetables as cooking melon and cucumber and value addition with natural coloring offers a remarkable opportunity to mitigate post-harvest losses. Furthermore, due to consumer demand for healthier substitutes as alternatives for artificial aditives, the study intends to apply natural and nutritious options while adding versatile food products to the beverage market. RTS beverage with components that could be obtained locally, such as cooking melon, aloe vera, cucumber, king coconut water and butterfly pea flower. A series of sensory evaluations were done for the optimization of ingredients by considering the ratios of the ingredients. Natural and selected additives were incorporated to improve the color intensity, flavor and storability. . Butterfly Pea Flower powder (BPF) was incooperated to improve the colour intensity of the product. Physio-chemical analysis were done, such as pH, color, titratable acidity, and Total Soluble Solids (TSS). The analysis of sugar content was done with high-performance liquid chromatography. The antioxidant activity and anthocyanin levels were also assessed. A total plate count was performed to evaluate the microbial quality. RTS showed a glucose to fructose ratio of 2.23:1, suggesting a higher glucose concentration in relation to fructose. The amount of anthocyanin in the sample was 21.37 mg/ml, indicating a notable presence of these advantageous pigments whereas the antioxidant activity was 20.83 %. During 60 days storage, Four treatments (T1P1; ambient, pH 4.19; T1P2; ambient, pH 3.88; T2P1; refrigerated, pH 4.19; T2P2; refrigerated, pH 3.88) were evaluated. T2P1 had better color retention and favourable microbiological quality along with the most stable pH, TA, and TSS levels. The preference for T2P1 was further reinforced by sensory assessments. Therefore, treatment T2P1 was identified as a most preferable formulation for prolonging the shelf life of RTS beverage without changing their quality and protecting safety significantly (α=0.05).

Keywords: Ready to Serve Drink; Cucumber; Blue Butterfly Flower; Natural Colors

ICSBE24_270

EVALUATION OF PHYSICOCHEMICAL PROPERTIES OF MONARAKUDUMBIYA (*Vernonia cinerea*) AND CURRY LEAVES (*Murraya koenigii*) MIXED HERBAL PORRIDGE POWDER

P.I. Maduwanthi*, K.H.T. Karunarathna, D.N. Kannangara
Department of Biosystems Technology, Faculty of Technology, University of Ruhuna, Sri Lanka
**Correspondence E-mail: pathirageisharamadu@gmail.com, TP: +94767865887*

Abstract: Monarakudumbiya (*Vernonia cinerea*) based herbal porridge is a well reputed dietary remedy for treating leukemia cancer in Sri Lanka. Not only leukemia *V. cinerea* has many therapeutic uses in the practice of traditional medicine. Every part of the plant can be used medicinally. It has been scientifically reported to possess anti-inflammatory, antidiabetic, Reno protective, anticancer, antiviral, antimicrobial activities this study was conducted to develop a porridge powder from *Vernonia cinerea* leaves. However, Monarakudumbiya (*Vernonia cinerea*) has a unique bitter taste. Therefore, an instant porridge powder was developed by incorporating curry leaves *Murraya koenigii.* This plant is also highly recognized for its activity on heart, anti-diabetic and cholesterol reducing property, antimicrobial activity, antiulcer activity, antioxidative property, cytotoxic activity, anti-diarrhea activity, phagocytic activity, and many more medicinal values. This study was conducted to develop a Monarakudumbiya (*Vernonia cinerea*) and curry leaves *Murraya koenigii* based instant herbal porridge by using a dehydration method. Each ingredient was separately dehydrated to 6 % moisture content. The recipe was slightly modified based on a preliminary sensory analysis. Six samples were evaluated for sensory properties. Monarakudumbiya (*Vernonia cinerea*) ratios were changed, and all other ingredients ratios were kept constant. Monarakudumbiya (*Vernonia cinerea*) and curry leaves *Murraya koenigii* 1:1 ratio sample was selected based on the results of the sensory evaluation. This selected porridge sample powder contains moisture 8.67 %, fat 11.76 %, ash 2.79 %, protein 1.74 %, fiber 22.89 % and carbohydrate 75.04 %.

Keywords: *Vernonia cinerea*; *Murraya koenigii*; Herbal Porridge Powder; Leukemia

ICSBE24_271

DEVELOPMENT OF VALUE-ADDED MUSHROOM SOUP CUBE ENRICHED MORINGA LEAF POWDER AND PUMPKIN POWDER

R.A.D.M.M.M.H. Bandara*, K.M.W. Rajawatta, K.H.T. Karunarathna
Department of Bio system Technology, Faculty of Technology, University of Ruhuna, Karagoda, Uyangoda, Kamburupitiya
**Correspondence E-mail: madhushikabandara1997@gmail.com, TP: +94774807329*

Abstract: Commercial soup cubes in the local market contained some unhealthy ingredients, such as monosodium glutamate and sulfur dioxide. Therefore, natural healthy cubes were prepared with value-added mushroom soup cube-enriched moringa leaf powder and pumpkin powder. The contents of the soup cube were dried oyster mushroom (*Pleurotus ostreatus*) moringa leaf, pumpkin, garlic, onion, corn flour, vegetable oil, black pepper, salt, and sugar.. They have a profound ability to boost the immune system, fight cancer, and improve the functioning of important organs, as they are full of proteins, vitamins, minerals, amino acids, antibiotics, and antioxidants. Due to their wide range of nutritional properties, these ingredients are prepared with value-added mushroom soup cube-enriched moringa leaf powder and pumpkin powder. All the ingredients were dried using different temperature: mushroom (55 ℃), pumpkin (65 ℃), moringa leaf (dried in 7 days at normal temperature), onion and garlic (55 ℃).Three different value-added mushroom soup cube enriched moringa leaf powder and pumpkin powder proportions were prepared by adding different concentrations of mushroom powder and other ingredients with constant value. Using the sensory tests (Hedonic scale), the preferred concentration was that containing the highest mushroom powder concentration. This mushroom soup cube-enriched moringa leaf powder and pumpkin powder contained 35.29 % ± 5.94 moisture, 6.64 % ± 2.55 lipids, 15.52 % ± 3.93 protein, 36.05 % ± 6.00 total carbohydrate, 6.5 % ± 2.54 ash, and 33.12 % ± 5.75 fiber. This is not available on the market, and it has a high nutrient content and better flavor.

Keywords: Oyster Mushroom; Moringa Leaf Powder; Pumpkin Powder; Malnutrition

ICSBE24_275

THE IMPACT OF LACTIC ACID FERMENTATION ON THE PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF CASSAVA STARCH FROM SELECTED SRI LANKAN VARIETIES

D.M.P.G.I.S. Bandara[1], W.D.S.S. Pemasinghe[1], S.P. Rebeira[2*]
[1]Department of Food Science and Technology, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila NWP, Sri Lanka
[2]Food Research Unit, Gannoruwa, Peradeniya, Sri Lanka
**Correspondence E-mail: srikanthi.rebeira@yahoo.com, TP: +94718358392*

Abstract: This study explores the impact of lactic acid fermentation on the physicochemical and functional properties of cassava starch derived from seven different local cultivars, including *Suranimala*, *Kirikawadi*, HORDI MU51, *Shani*, *Swarna*, CARI555, and Mu-51. *Lactobacillus delbrueckii* and *Streptococcus thermophilus* were utilized as starter cultures in the fermentation process. The chemical composition, Whiteness Index, Swelling Power, Solubility Index, Water (WHC) and Oil Holding Capacities (OHC), Amylose Content, were determined for Non-Fermented Cassava (NFC) starches and Lactic Acid Fermented Cassava (LAFC) starches in all varieties. The starches were characterized using Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). Comparison between freshly extracted starches with the LAFC starches of the same varieties showed significant alterations in the chemical composition, and textural properties. A notable decrease in pH was observed in LAFC starch compared to NFC starch. Although LAFC starch exhibited slightly lower amylose content in *Shani* and CARI 555 varieties compared to NFC starch of the same variety, while other varieties slightly increased after fermentation, and the values were not significant at $p<0.05$.The Whiteness Index (WI) showed significant differences among the LAFC starches, with values ranging from 95.13±0.05 for HORDI-MU1 to 90.52±0.39 for *Suranimala*. In comparison, the NFC starches from the same varieties exhibited WI values ranging from 95.37±0.19 to 94.7±0.38, respectively. The Solubility Index (SI) and OHC were not significantly different for LAFC starches. Swelling Power and WHC of LAFC starches varied significantly among varieties, with Swelling Power (SP) ranging from 8.34±0.6 % to 11.19±0.03 % and WHC from 0.97±0.02 % to 1.33±0.06 %. The FTIR results indicated a consistent peak pattern in NFC and LAFC starches, with a notably increased peak intensity for LAFC starches at 1700 cm^{-1}. SEM analysis showed fractured granules and roughened surfaces, highlighting the impact of fermentation. So as here implies Fermentation resulted in a notable decrease in pH, WI, SP, OHC, and an increase in WHC, SI in all LAFC starches compared to NFC starches. The results suggested that lactic acid fermentation provides a greater extent of cassava starch modification within a shorter period of time. Based on the results, selecting varieties with desirable properties can utilize for the development of improved cassava-based products. These findings offer valuable insights for the food industry in developing novel starch-based products with improved functional attributes.

Keywords: Fourier Transform Infrared Spectroscopy; Lactic Acid Fermentation; Scanning Electron Microscopy; Whiteness Index

ICSBE24_677

DETERMINATION OF SUITABILITY OF AN ABANDONED PADDY LAND FOR RE-CULTIVATION IN TERMS OF SOIL & WATER QUALITY IN HODARAWAALADENIYA YAYA HOMAGAMA, SRI LANKA

M.T. Ravinath*, T. Denagama
University of Vocational Technology/100, Kandawala Road, Ratmalana
**Correspondence E-mail: thushararavinath@gmail.com, TP: +94777720304*

Abstract: This study investigates the spatial and temporal variations in water and soil quality of the abandoned paddy land at Hodarawaaladeniya yaya, Homagama, Sri Lanka, focusing on identifying the suitability for recultivation of the paddy. The extent of the selected land was 3.24 acres, and the length of the supply canal section considered was 194 m. The water samples were collected from February to June 2024 at the supply canal along the selected locations, and Electrical Conductivity and pH values were checked and analysed. The soil samples were collected and analysed for key parameters including pH, Electrical Conductivity, available Phosphorus, available Potassium, Organic Matter, and Soil Texture. This analysis was done based on the values and information recommended by the regulatory bodies. The conclusion was that the water source would have no harmful effects therefore it was in a favorable condition for paddy cultivation. The soil properties of EC, available Phosphorus, available Potassium, Organic Matter values, and Soil Texture were within the prescribed range. However, the acidity of the soil has increased excessively in June. Therefore, if this field is cultivated in the next season, a soil sample should be taken before planting and checked to determine whether applying Dolomite is recommended. Otherwise, considering all these facts, it can be concluded that this land is suitable for the recultivation of the paddy. It appears that testing the soil and water quality for six months is not sufficient. By examining these samples for one year, the results of this investigation will be more sensitive and comprehensive.

Keywords: Abandoned Paddy Land; Temporal; Spatial; Water Quality; Soil Quality

ICSBE24_276
POTENTIAL OF NATURAL RED PLANT PIGMENTS AS ALTERNATIVES TO ARTIFICIAL COLORANT (E122) IN STRAWBERRY FLAVORED ICE CREAM

J.A.S.A. Jayasingha, W.P.M.M. Weerawardhana, R.A.C.H. Seneviratne*
Department of Food Science and Technology, Wayamba University of Sri Lanka, Makandura, Sri Lanka
**Correspondence E-mail: haily.seneviratne@wyb.ac.lk, TP: +94773415381*

Abstract: This study evaluated the potential of replacing the widely used artificial red colorant (E 122) in strawberry-flavored ice cream with natural red color extracts from sources of red dragon fruit (*Hylocereus costaricensis*), beetroot (*Beta vulgaris L.*), bougainvillea (*Bougainvillea glabra*), and *Hibiscus rosasinensis* using spectrophotometry and calorimetry. The research examines the stability of red color natural pigments at a temperature of -18 °C to address the instability reported with E122. Eight colorants were prepared by equivalent dry weights of dried and fresh forms of four plant sources using ultrasonication in extraction. The pH of hibiscus colorants were maintained below 2 with citric acid. The study examined initial pigment concentration, pigment degradation with time, and color stability after incorporation into the ice cream base. Furthermore, sensory evaluations involving 30 panelists were conducted to evaluate the color and overall acceptability of ice creams prepared from ice cream bases incorporated with natural red color and E122 for comparison purposes. The results showed that dried bougainvillea colorant had the highest initial pigment concentration (133.64±1.06 mg/L), while other colorants had significantly lower values. Fresh dragon fruit colorant extract exhibited the minimum color degradation percentage (3.05±0.02 %) over a 21-day storage period compared to the other samples. Once mixed with the ice cream base, the dried bougainvillea showed the least color change (ΔE=0.66±0.18), while others showed significantly higher color changes. Fresh dragon fruit and dried beetroot were reported as excellent natural colorants, closely resembling artificial ones in sensory evaluations. Spectrophotometry results showed that fresh dragon fruit is the preferred natural colorant, while calorimetry showed that dried bougainvillea is the most suitable alternative. However, sensory evaluations accepted both of these natural colorants. This research supports promoting natural colorants in food and enhancing consumer safety. Further research on long-term stability, economic feasibility, and suitability are needed for comprehensive understanding.

Keywords: Colorimetry; Spectrophotometry; Natural Colorants; Ice Cream Base

ICSBE24_048

THE APPLICABILITY OF SMART WATERING ON REDUCING ROOM TEMPERATURE

R.H.G.N. Deshan*, K.B.A. Silva
Department of Construction Technology, Faculty of Technology, Wayamba University of Sri Lanka, Lional Jayathilaka Mawatha, Kanadulla, Kuliyapitiya, 60200, Sri Lanka
**Correspondence E-mail: nevindudeshan99@gmail.com, TP: +94702406017*

Abstract: Smart watering systems use precision irrigation to optimize water use and promote plant health by targeting water delivery to plant roots at timed intervals. This study examines the potential of smart watering to serve as an alternative to conventional cooling methods in indoor environments. The investigation was structured around comparative analyses in two controlled environments: Room A, which was outfitted with a smart watering system, and Room B, which was left in its original state without any modifications. The experimental setup included a variety of conditions, differentiating by number of plants and the frequency of watering, along with comparisons to conditions without any watering. This design was intended to rigorously test the cooling efficacy of the smart watering system under diverse and controlled conditions. The primary findings from this study suggest that the implementation of smart watering can lead to a significant reduction in indoor temperatures. In Room A, where the watering is applied, temperatures were consistently lower than those recorded in Room B, which served as the baseline control. Statistical analysis was employed to assess the impact of various experimental scenarios. It was observed that scenarios involving a higher density of foliage, such as ten plants watered every 30 minutes (Case 2) and fifteen plants subjected to the same watering regimen (Case 5), were particularly effective in reducing temperatures. These scenarios achieved a marked decrease in the average temperature of Room A, highlighting the efficiency of smart watering when combined with substantial plant coverage and frequent irrigation. In contrast, Room B's temperature remained stable across all test scenarios, confirming its role as an effective control setting. This stability underscores the reliability of the comparative results obtained from Room A and supports the conclusion that smart watering systems can play a crucial role in indoor temperature regulation.

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

ICSBE24_046

SYSTEMATIC REVIEW ON VERTICAL GREENERY SYSTEMS IN INDOOR ACOUSTIC CONTROL: ADDRESSING NEEDS, EXPLORING PROSPECTS, AND HIGHLIGHTING BENEFITS

M.A.U.C. Wijeratne[1*], H.A.T.N. Perera[1], R.U. Halwatura[2], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka
[2]Department of Civil Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: chinthaniwijeratne@gmail.com, TP: +94711194804*

Abstract: Population growth and increased development in urban areas and industries amplified the problem of interior noise pollution, affecting the health and productivity of people. The need for innovative approaches to eliminating or reducing it to the barest minimum has become apparent. Vertical Greenery Systems (VGS) is a versatile technique that offers effective noise attenuation, beautification, and health benefits. This systematic review aims to identify the requirements, opportunities, and advantages of VGS as an effective noise barrier in an indoor environment. Results were yielded on Google Scholar, ResearchGate, Academia, and ScienceDirect databases following keywords "vertical "greenery" system" AND "benefits" OR "concerns" AND "indoor sound absorption" OR "indoor sound level reduction" by using AND, OR Boolean operators. The initial count was reduced to 56, including journals, magazines, symposium articles, conference papers, peer-reviewed papers, review articles, book chapters and reviews, and case reports, following the PRISMA inclusion and exclusion criteria from 2012 to 2024. Two real-life case studies, Bosco Vertical in Milan and One Central Park in Sidney, demonstrate the efficacy and feasibility of VGS in the real world. The paper elaborates on the challenges of VGS recalled to climate change accommodation, plant choice, and management of vegetation. It focuses on future advancements like the application of smart systems for the maintenance and monitoring of VGS, the selection of suitable plant species, and possibilities of utilization and incorporation of VGS into building construction. 72 % of the studies specifically mentioned VGS for outdoor acoustic applications and the effect of green roofs on acoustic barriers, but none of the extensive research reports on VGS for indoor acoustic purposes by highlighting their prospects. This evaluation provides the basis for future research and development and fosters the implementation of VGS as a solution to enhance acoustic comfort as well as environmental quality in construction procedures.

Keywords: Acoustic Control; Indoor Environment; Noise Pollution; Vertical Greenery Systems; Benefits; Future Directions

ICSBE24_078

THE IMPACT OF INTERIOR DESIGN ENVIRONMENT ON EMPLOYEE SATISFACTION: AN INSIGHT ON STATE OFFICES IN SRI LANKA

K.I. Kalpani, J.C. Ratnayake, P.L. Wimalaratna, J. Wijesundara
School of Architecture, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
**Correspondence E-mail: kikalpani1999@gmail.com, TP: +94712500171*

Abstract: Job satisfaction is crucial in corporate settings, as it influences employees' attitudes and performance. While previous studies have highlighted the importance of workplace conditions on job satisfaction across various countries, there is a notable lack of research within the Sri Lankan context, particularly in state offices. This research investigates the factors affecting employee satisfaction in Sri Lankan state offices, with a specific emphasis on interior design. The study aims to determine how specific interior design environmental cues impact employee satisfaction. Based on a comprehensive literature review, the independent variables identified include floor layout, furniture arrangement, lighting, colour scheme, air temperature, noise and acoustics. This study employs a mixed-method approach, combining quantitative and qualitative data, to explore the impact of the interior design environment on employee satisfaction in three high-profile state offices in Colombo and Sri Jayewardenepura. Primary data were collected through observations and structured questionnaires distributed across various departments, yielding 50 responses from each office, resulting in a total sample size of 150 participants. On-site measurements for lighting levels, temperature, and noise levels, were taken, while furniture, colour, and floor layout were assessed through visual inspections. Questionnaire responses were analysed using SPSS statistical software. The research found that floor layout, furniture, lighting, and colour significantly impact employee satisfaction, whereas temperature and noise have minimal impact. The study offers design recommendations to improve state office environments, emphasizing the importance of passive design techniques to enhance user-friendliness and environmental sustainability, ultimately increasing employee satisfaction. This research fills a critical gap in the literature and provides practical insights for improving the working conditions in Sri Lankan state offices.

Keywords: Employee Satisfaction; Interior Design Environment; Floor Layout; Furniture Arrangement; Lighting; State Offices

ICSBE24_247

THERMAL SATISFACTION OF STUDENTS IN INDOOR SPACES AT ACCADAMIC INSTITUTIONS

K.A.B. Weerasinghe, A.G.D.T.N. Nanayakkara*
Division of Civil Engineering Technology, Institute of Technology University of Moratuwa
**Correspondence E-mail: thivankan@itum.mrt.ac.lk, TP: +94778281537*

Abstract: Thermal comfort plays a major role in teaching and learning environment in an academic institution. Thermal comfort in a class room governs by key parameters such as temperature, humidity, air speed, sunlight and importantly the location of the institute. The thermal comfort in a class room can be enhanced to different levels by introducing natural and mechanical ventilation systems. This study focused on to identify the thermal comfort levels in occupied class rooms with different ventilation systems. Two types of class rooms which are ventilated with air conditioners and ventilated with mechanical fans with natural systems (doors and windows) were selected for the study. The human comfort levels were obtained using a questionnaire survey with respect to the parameters, indoor temperature, indoor and outdoor wind speeds and humidity. The thermal satisfaction levels and stress levels of students were evaluated using the Fanger method and the Center for the Built Environment (CBE) thermal comfort web-based tool based on the Mean Vote (PMV), Predicted Percentage Dissatisfied (PPD), and Thermal Sensation Votes (TSV). The results of the study revealed that the most students prefer a temperature range of 23 °C – 25 °C and humidity range of 60 % - 65 % as the comfortable environment which enhance productivity of the learning process.

Keywords: Thermal Satisfaction; Fanger Model; CBE Thermal Comfort Tool; Indoor Environment

ICSBE24_245

A SYSTEMIC REVIEW OF THE ROLE OF INDOOR PLANT-ASSOCIATED MICROBIAL COMMUNITIES IN AIR PURIFICATION

J.A.S.G. Randimali*, E.M.G.D.B. Ekanayake, B.K.A. Bellanthudawa, G.Y. Jayasinghe

Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Matara, 81100, Sri Lanka

**Correspondence E-mail: gayeshashalini@gmail.com, TP: +94766172008*

Abstract: Indoor air quality is a critical factor of concern since it affects human health, with VOC's, particulate matter and bio contaminants, which are known to cause respiratory and cardiovascular ailments. Although the use of indoor plants is well understood in terms of their visual and psychological purposes, their potential to improve indoor air quality through microbial communities associated with these plants has received much interest in recent years. This systematic review seeks to understand how the microbial communities living on indoor plants enhance air cleaning. Therefore, a comprehensive systematic literature survey was conducted; (1) to identify the main microorganism types associated with indoor plants, (2) to examine their air purification mechanisms, and (3) to assess factors affecting their air purification potential and challenges. The search procedure involved using Google Scholar and Pub med to screen peer-reviewed scholarly research communications published in English between 2014-2024. The search used the key terms "indoor plants", "indoor air quality", and "microorganisms", yielding 286 relevant articles. After screening, 42 papers were selected for data analysis. The majority of studies (n=40) have consistently shown that plants are in constant association with a wide array of bacterial and fungal species. The main types of microorganisms found in association with indoor plants in air purification are those residing belowground (in the soil rhizosphere) (n=33) and aboveground (on leaf surfaces or phyllo sphere) (n=25). Plant-associated microorganisms eliminate or transform a wide range of air pollutants through various mechanisms, including biodegradation and CO_2 fixation. Microalgae possess a unique metabolic versatility, with the ability to engage in autotrophic (photosynthetic), heterotrophic, and/or mixotrophic metabolisms. This adaptability allows microalgae to not only fix CO_2 but also to improve indoor air quality by degrading hydrocarbons. Bacteria, such as *Arthrobacter aurescens*, *Pseudomonas putida*, and *Bacillus cereus*, and *Ochrobactrum intermedium* can degrade pollutants like formaldehyde, benzene, toluene, ethylbenzene, and xylenes. However, the effectiveness of indoor plant-based air purification is influenced by plant species (n=22), leaf area (n=14), environmental conditions (light, temperature, humidity) (n=28), substrate type (n=17), and plant genotype (n=7). This study suggests that proper maintenance and selection of plant species are crucial to mitigate these risks and ensure a healthy indoor environment because indoor plants and their associated microorganisms can pose potential hazards, such as allergens, pathogens, and opportunistic infections. The key gap is the lack of standardized methodologies and the need for long-term studies to better capture the dynamic and evolving nature of these interactions.

Keywords: Air Pollutants; Indoor Air Quality; Phytoremediation; Plant-associated Microorganisms; Rhizosphere; Phyllo Sphere

ICSBE24_246

ASSESSING CARBON SEQUESTRATION IN URBAN ARCHITECTURE: THE POTENTIAL OF BUILDING-INTEGRATED VEGETATIVE SYSTEMS

T.T. Ranasinghe[1*], H.A.C. Priyankara[2], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, Kamburupitiya, Matara, 81100, Sri Lanka
[2]Department of Biosystem Technology, Faculty of Technology, University of Ruhuna, Sri Lanka
**Correspondence E-mail: ranasinghe106at@ags.ruh.ac.lk, TP: +94711125406*

Abstract: Cities are considered as one of the key sources of carbon emissions, yet they can act as carbon sinks which calls for understanding the dual role of cities in environmental change and stewardship. Unfortunately, there is a dearth of literature that explores carbon storage and sequestration in building integrated vegetation. There are several ways through which such challenges can be addressed and one of the most effective ways is through building integrated vegetative structures which are nature – based solutions. The objective of this study was to evaluate the potential of vegetative structures including green roofs, green walls, and landscaping trees to capture CO_2 in urban built environment. Buildings integrated with vegetative structures and located in urban environments were selected for field data collection that required for quantifying the carbon sequestration. Calculations were conducted individually for different selected types of structures per area, per time. The I - tree eco tool which provides values for carbon sequestration and storage, pollution removal values were used as a supportive tool for the study. In the findings, the selected structures significantly contributed to carbon sequestration and demonstrate distinct benefits in carbon absorbance with higher efficiency in limited spaces in urban environments. Furthermore, findings provide guidelines for designing and implementation of vegetative structures into the building environment and encourage stakeholders including architects, construction site owners, engineers, and policy makers to focus on this application. This study will be significant in determining future urban planning and development with the view of creating sustainable cities that promote environmental health and resist sir pollution in urban areas.

Keywords: Carbon Sequestration; Green Infrastructure; Sustainable Design; Urban Building; Environmental Benefit; Vertical Greenery

ICSBE24_788

BIOMIMICRY IN SUSTAINABLE ARCHITECTURE AND CONSTRUCTION: STATE-OF-THE-ART STRATEGIES AND AI APPLICATIONS

K. Keerthana[1*], W.A.D.C.S. Perera[1], T.A.N.T. Perera[2], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka
[2]Department of Export Agriculture, Uva Wellassa University, Sri Lanka
**Correspondence E-mail: keerthanakanapathipillai4@gmail.com, TP: +94771178780*

Abstract: Biomimicry combines biology and architecture, shaping bio-inspired sustainable developments from ancient times to the present. This systematic review explored 45 research articles using databases such as Google Scholar, ScienceDirect, and MDPI from 2015 to 2024 gathered on 10 May 2024. The search strings used included; "Biomimicry" AND "Sustainable Architecture" OR "Sustainable Building Solutions" AND "AI Application" OR "AI Design Solutions" at least three search strings included in the keywords, title or abstract. Only peer-reviewed open-access articles are considered. We excluded the publications written in languages other than English, short papers that did not provide substantial content, and papers lacking proper citations and removed the duplicates. This study analyzes how biomimicry shapes sustainable architecture and the state-of-the-art nature-inspired strategies that are currently used. Further, it summarizes how AI enhance biomimetic design in construction for improved resilience and efficiency and discusses successful examples of biomimetic designs in sustainable architecture and what lessons they offer. Computational design and digital manufacturing enable architects to study and replicate biological models. There are several tools utilized in biomimicry such as Functional Modelling, Natural language analysis, IDEA-inspire software, SAPPHIRE model, TRIZ (Theory of Inventive Problem solving), AskNature, BioTRIZ. "AskNature" is an important tool; it is the only tool available to the public. BIDARA (NASA's Periodic Table of Life), an open-source software program that enables discovery via design, taking out inspiration from natural systems and human achievements. Pre-Trained Language Model (PLM) can understand human language. BERT and GPT mostly used in Natural Language Processing (NLP). Generative Pre-Trained transformers like ChatGPT serves as a beginning point for the designer's study approach to identify biological design solutions. AI handles massive biomimicry databases and automatically updates it and saves time. Applying deep learning to design challenges enables designers to detect biological knowledge and information.

Keywords: Biomimicry; Sustainable Architecture; Sustainable Building Solutions; AI Application; AI Design Solutions

ICSBE24_080

THE IMPACT OF LEADERSHIP STYLES ON TOTAL QUALITY MANAGEMENT IN CONSTRUCTION SMES IN SRI LANKA

J.M.N.K.D. Jayaweera[1*], D.D.N. Dissanayake[1], G.H.S.P. De Silva[2]
[1]LJMU, UK
[2]SLIIT , New Kandy Rd., Malabe, Sri Lanka
**Correspondence E-mail: priyanwadadesilva@gmail.com, TP: +94771843651*

Abstract: Today, maintaining quality standards is crucial for every construction organisation to succeed and survive in the ever-changing business landscape. Adopting a proper Total Quality Management (TQM) system would be a wise move to accomplish such standards by addressing the challenges and complexities inherent to the industry. However, TQM can only be adequately implemented and operated with proper leadership. Thus, this research investigates the impact of transformational (TFL) and transactional (TSL) leadership styles on the Critical Success Factors (CSF) of TQM in Small and Medium Scale Enterprises (SMEs) engaged in building construction projects in Sri Lanka. The study on TSL, TFL and their impacts on CSFs of TQM in SMEs stemmed from a quantitative approach, by administering a questionnaire survey distributed among the managerial-level professionals. The collected data was analysed using descriptive statistics, such as mean, weighted average, and percentage counts, through a Likert scale analysis. Finally, a correlation analysis explored the relationship between leadership styles and CSFs of TQM. The research findings revealed that proper leadership is crucial in implementing a better TQM system in construction SMEs. Furthermore, the research indicates that the two leadership philosophies have varying impacts on TQM's CSFs. The TSL has a high impact, while the TFL has a moderate effect on CSFs. Both leadership styles reported a positive linear relationship with the CSFs of TQM. However, TFL shows a moderate relationship compared to the strong relationship demonstrated by the TSL with the CSFs of TQM in the SMEs engaged in building constructions in Sri Lanka. The study would be helpful for SMEs' top management to identify the leadership style to successfully implement a TQM system within the organisation, thereby enhancing the quality of the product.

Keywords: Total Quality Management; Critical Success Factors; Leadership; Transformational Leadership Styles; Transactional Leadership Styles

ICSBE24_079

IDENTIFY POSSIBLE CONTRACTUAL CLAIMS TO THE CONSTRUCTION CONTRACTOR DUE TO UNPRECEDENTED ECONOMIC CRISIS AND ITS IMPACT ON THE CONSTRUCTION INDUSTRY IN SRI LANKA

Y.C. Nandasiri[1*], K.A.N. Gunarathna[2], B.C.T.M. Karunaratne[3]
[1]Freelance Quantity Surveyor
[2]Lecturer, Sri Lanka Institute of Information Technology, New Kandy Road, Malabe, Sri Lanka
[3]Oxford College of Business, Colombo, Sri Lanka
**Correspondence E-mail: karunarathne7tania@gmail.com, TP: +94716773345*

Abstract: The construction industry is closely related to the majority of other economic activities of a nation, which is regarded as significant in terms of economic expansion. As it is one of the most susceptible sectors to a financial downturn, the current economic crisis has had a substantial impact on the construction industry in Sri Lanka. Construction projects encounter the challenge of exceeding the expected time and cost of construction, which was influenced by the unprecedented economic crisis, making construction claims admissible. Hence, this study aims to identify the available claims to construction contractors due to the economic crisis and unprecedented price increases in the construction industry in Sri Lanka. The impacts of the economic crisis on the construction contractors in Sri Lanka and the challenges associated with contractual claims during an economic crisis were examined through the literature review. The research employed a mixed method, which includes both qualitative and quantitative approaches, by conducting a questionnaire survey and a series of eight semi-structured interviews with experts in the construction industry selected through purposive sampling to identify and analyse the negative impact on the contractors due to the economic crisis and to evaluate their recommendations for addressing potential claims within the construction industry in Sri Lanka. The data analysis revealed that the claims under adjustment for changes in legislation and due to delays caused by authorities, delay claims with prolongation cost, price fluctuation claims as an ex-gratia, and force majeure claims are the possible claims to construction contractors due to the economic crisis, which has contributed to the high exchange rate of the national currency, the inflation of building materials, foreign currency shortages, taxes, and government policies. Furthermore, the study provides valuable insights to manage claims in a more effective way, including effective planning, ensuring timely payments of funds, implementing value engineering practices, optimising financial utilisation, establishing robust control and administrative systems, and minimising variations in contractual claims to the construction contractor due to the unprecedented economic crisis in Sri Lanka.

Keywords: Economic Crisis; Construction Claims; Sri Lanka

ICSBE24_114

DEVELOPMENT OF NEW STRATEGIES FOR MITIGATING BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION BARRIERS IN SRI LANKAN CONSTRUCTION SECTOR

S. Sivatharshan[1*], M. Kesavan[2]
[1]Department of Construction Technology, Faculty of Technology, Wayamba University of Sri Lanka
[2]Lional Jayathilaka Mawatha, Kanadhulla , Kuliyapitiya, 60200, Sri Lanka
**Correspondence E-mail: sivalingamsivatharshan@gmail.com, TP: +94773488417*

Abstract: The Sri Lankan construction sector is crucial to the country's economic growth but faces several challenges that hinder project success. This research explores the potential of Building Information Modelling (BIM) to address these challenges and identifies strategies to overcome the barriers to its adoption in Sri Lanka. The study involved 64 construction professionals from various organizations, selected through snowball sampling. Structured interviews were conducted to assess the current state of BIM usage, adoption levels, proficiency, and the perceived challenges and opportunities within the sector. Content analysis was employed to interpret the data and extract meaningful insights. The findings highlight several significant barriers to BIM adoption in Sri Lanka. The findings highlight several significant barriers to BIM adoption in Sri Lanka. These include a lack of knowledge about BIM (70 %), inadequate BIM software knowledge (52 %), insufficient IT infrastructure (57 %), and a lack of education and training (49 %). Despite these challenges, the study also identifies potential strategies to overcome these barriers, such as enhancing BIM education at the undergraduate level (66 %) and increasing workshops, courses, and specialized conferences related to BIM (55 %). This study contributes to filling a critical knowledge gap by developing innovative strategies tailored to the local context, which can enhance the efficiency and effectiveness of construction projects through successful BIM adoption. While the findings are most relevant to Sri Lanka, they may also be applicable to similar developing countries. However, the results are based on current data, and future technological and regulatory changes could impact the applicability of the proposed strategies. The research concludes that the effective use of BIM-based applications can significantly improve service delivery efficiency in the Sri Lankan construction industry.

Keywords: Building Information Modelling; Sri Lankan Construction Sector; Implementation Barriers; Strategies; Framework

ICSBE24_104

ASSESSING THE COMPETENCE OF THE SRI LANKAN ENGINEERS IN BIM BASED APPLICATION

L.R.S.A. Croos[1*], M. Kesavan[2]
[1]*Department of Construction Technology, Wayamba University of Sri Lanka*
[2]*Lional Jayathilaka Mawatha, Kanadhulla , Kuliyapitiya, 60200, Sri Lanka*
**Correspondence E-mail: croossaran@gmail.com, TP: +94766949269*

Abstract: Building Information Modeling (BIM) has been adopted by many firms in many other countries, Sri Lanka's firms seem to be far behind in this current trend of adopting BIM technology. In order to comprehensively evaluate the proficiency of engineers in the utilization of BIM-based applications for Sri Lanka's AEC firms to successfully implement BIM in their current working processes. Fifty construction professionals, with various levels of expertise, were selected using the snowball sampling method. Especially, author chooses exponential non-discriminative snowball sampling method. Data collection via questionnaire survey allows to collect data about opinions, experiences, opportunities, barriers, knowledge, skill and attitude by asking people directly. Qualitative analysis will be performed to identify common themes, patterns, and key insights. This research investigated the current state of BIM competency among engineers in Sri Lanka's construction industry. By addressing the existing gaps in BIM adoption within the Sri Lankan context, this research aimed to identify challenges, barrier, and opportunities. Author assessed current engineering attributes in BIM-based applications and developed guidelines for competency advancement. The current study addresses the challenges and opportunities of BIM adoption for upgrading engineering practices within the Sri Lankan construction sector, and barriers of BIM based applications for upgrading engineering policies. Accordingly, the study opens a way for assess the engineering attributes in BIM based application at the current stage in Sri Lanka, and develop guidelines for the competency advancements in engineering practices. The study outcomes would enable policymakers, and educational institutes to initiate appropriate strategies to educate, train, and adopt BIM in construction projects. This study assessed individual knowledge of BIM only in Sri Lanka. The findings are based on current data, but future technological changes could impact their relevance.

Keywords: Building Information Modeling; Sri Lankan Construction Sector; BIM Competence; Barriers, and Challenges of BIM Adoption; Opportunities in BIM Adoption and Utilization

ICSBE24_551

AN ANALYSIS OF PERCEPTUAL DIFFERENCES OF "QUALITY" IN THE CONSTRUCTION INDUSTRY

A.M. Kalyani*
Project Manager, Chartered Architect
**Correspondence E-mail: kabesekara@yahoo.com, TP: +94718642669*

Abstract: "Quality" is a debated concept among the design and construction personnel in the construction industry due to its subjective nature, so identifying an objective quality definition on common ground is necessary. Therefore, this study identified the prevailing quality concepts between these two stakeholders of a construction project and the structuring of their quality image. For this task, a literature survey and open interviews were used as the research method. The results show that the most common quality definition is 'as per the specifications and drawings'; quality perception depends on the occupation, education, experience, and organizational culture; and the complexity and clarity increase with more exposure to these affecting factors. The quality image is built in a web-like structure within the pool of cultural levels. Experience was the most affecting cultural element for perception, with education and organizational cultures being the secondary. Therefore, the highest concern in the preparation of project documents, specifically the specifications and drawings by consultants and implementing them at site as specified, is necessary because they specify the required level of quality considering every aspect of a construction project. At the same time, the incorporation of quality aspects into education through educational policies and the strengthening of standards, rules, and regulations by regulatory and standard institutes as a nation are necessary. Seminars, courses, continuous professional developments, building strong relationships in project teams and motivating them, and incorporating quality policies into organizational strategies by individual organizations are recommended.

Keywords: Quality; Quality Concepts; Quality Perception; Qualitative Method; Culture

ICSBE24_159

DEVELOPING RISK MANAGEMENT FRAMEWORK FOR CONSTRUCTION INDUSTRY FACING FUTURE CRISIS CHALLENGES

S.K. Kaushalya[1*], W.M.C.L.K. Wijekoon[2], P.H.Y. Buddhini[3], R.P.H.S. Bandara[4]

[1]Value management service,352/17, 1st floor, Galle Road, Moratuwa, Sri Lanka
[2]Department of Quantity Surveying, Faculty of Engineering, SLIIT, New Kandy Road, Malabe, Sri Lanka
[3]Arch International (Pvt) Ltd, No. 275, Nawala Road, Nawala
[4]Department of Civil Engineering, Faculty of Engineering, SLIIT, New Kandy Road, Malabe, Sri Lanka
**Correspondence E-mail: phyashodhabuddhini@gmail.com, TP: +94779895606*

Abstract: The construction industry in developing countries like Sri Lanka is highly vulnerable to economic downturns, pandemics, and supply chain disruptions. This research addresses the need for a structured risk management framework to guide the sector through such crises. Historically, inadequate risk management has exposed the industry to significant financial, operational, and safety risks. The study gathered data through a questionnaire survey of 34 participants and semi-structured interviews with 7 experts. The 5-point Likert scale and Relative Importance Index (RII) methods were used to analyze the survey data, while thematic analysis was applied to interview responses. The research identified 9 critical risk factors affecting the construction industry during crises, including health and safety concerns, project delays, and supply chain disruptions. It also proposed effective methods and tools for analyzing and controlling these risks. The study emphasizes the importance of proactive risk management, accurate data analysis, and stakeholder collaboration. It highlights the need for adaptability and real-time monitoring in risk management strategies. The culmination of this research is a holistic risk management framework designed to mitigate future crisis challenges. The framework integrates existing models' stakeholder roles, technological advancements, and key elements. It provides practical steps for continual improvement and resilience in the construction industry. This research contributes significantly to the field by offering insights and recommendations that ensure the sustainability and resilience of construction projects. It stresses the critical role of proactive strategies, effective risk analysis tools, and collaboration in achieving successful project outcomes in a dynamic and crisis-prone environment

Keywords: Economic Crisis; Construction Industry; Risk Management; Risk Management Framework

ICSBE24_055

DEVELOPMENT OF A NEW GUIDING TOOL TO ENHANCE THE CONSTRUCTION INDUSTRY'S AWARENESS OF BIM-BASED APPLICATIONS IN SRI LANKA AGGREGATE

S. Nishalini, M. Kesavan*
Department of Construction Technology, Faculty of Technology,
Wayamba University of Sri Lanka, Kanadulla, Kuliyapitiya, Sri Lanka
**Correspondence E-mail: sivarasanishalini99@gmail.com, TP: +94756510288*

Abstract: Building Information Modeling (BIM) is emerging as a transformative force in the global construction industry, enhancing project design, collaboration, and efficiency. Despite its potential, BIM adoption in Sri Lanka is limited due to a lack of awareness and understanding among industry professionals. This research documents the development of a comprehensive BIM guiding book aimed at increasing awareness and facilitating BIM integration within the Sri Lankan construction sector. The study identifies key opportunities, needs, barriers, and challenges associated with BIM adoption in Sri Lanka through extensive literature reviews and expert interviews. The resulting BIM guiding book addresses these factors, offering practical insights, and step-by-step guidance tailored to the local context. It simplifies complex BIM concepts and provides actionable recommendations for transitioning to BIM practices. Key findings reveal significant potential for cost savings, improved project outcomes, and streamlined workflows through BIM. However, challenges such as limited technical expertise, and high initial costs must be overcome. The guiding book underwent rigorous reliability and validity tests, including expert reviews, ensuring its reliability and effectiveness. This initiative represents a significant advancement for the Sri Lankan construction industry, fostering a culture of BIM proficiency and paving the way for a more efficient, innovative, and competitive sector.

Keywords: Building Information Modeling, Construction Industry, BIM Adoption, Manual Guiding Tool

ICSBE24_077

BOOSTING CONSTRUCTION PROJECT PERFORMANCE: CAN ENTREPRENEURIAL LEADERSHIP MEDIATE THE IMPACT OF CREATIVITY?

H.M.T.J. Hellarawa[1*], G.H.S.P. De Silva[2]
[1]LJMU, UK
[2]SLIIT, New Kandy Road, Malabe
**Correspondence E-mail: priyanwadadesilva@gmail.com, TP: +94771843651*

Abstract: To achieve the project's success and competitive advantage, construction organisations must concentrate on the project's creativity and performance. In achieving both these aspects, a construction project should have proper leadership. However, different leadership styles can impact project creativity and performance differently. An appropriate leadership style is necessary to maintain the success of the project and the construction organisation. One such style that can significantly influence these aspects is Entrepreneurial Leadership (EL). Hence, the study aims to explore the mediating effect of EL on the relationship between project creativity and performance. The study on the link between project creativity and performance and the impacts of entrepreneurial leadership was derived from a quantitative approach, employing a questionnaire distributed among 70 managerial-level professionals in Sri Lankan construction organisations engaged in building projects. Data analysis incorporated descriptive statistics with mean, standard deviation, frequency, and percentage counts via a 5-point Likert Scale analysis. Moreover, through A med-mod analysis, the study explored the mediation effect of EL on the relationship between project creativity and performance. Finally, the study revealed that EL significantly enhances both project creativity and performance. While the direct impact of creativity on performance was strong, the mediation effect of EL was statistically non-significant. Moreover, the results indicated the significance of EL in fostering an innovative environment and improving project efficiency in building construction projects in Sri Lanka. The study would be helpful for managerial-level professionals to decide the level of usage of EL to foster innovation within the organization and how EL to be used to enhance project creativity and performance.

Keywords: Entrepreneurial Leadership; Project Performance; Project Creativity; Mediation Effect

ICSBE24_791

BUILDING INFORMATION MODELING (BIM) BASED EVALUATION SYSTEM FOR THE DEVELOPMENT OF GREEN BUILDINGS IN TERMS OF USING LOCAL CONSTRUCTION MATERIALS

S.S. Ahmed, M.W.K. Mufeen, M.F.M. Ishqy*, A.C.A. Suja
Department of Civil Engineering, Faculty of Engineering,
South Eastern University of Sri Lanka, Sri Lanka
**Correspondence E-mail: ishqyfareed@seu.ac.lk, TP: +94777073752*

Abstract: The construction sector is a major driver of socio-economic growth, particularly in developing countries such as Sri Lanka. However, it is also one of the largest contributors to environmental pollution. The use of local construction materials is recognized as a sustainable strategy for reducing the environmental impact of building construction. However, evaluating the greenness of buildings in terms of local material usage remains complex due to the lack of standardized methodologies and tools. Various green rating systems, which typically involve manual point calculations, are employed globally. The advent of Building Information Modelling (BIM) is revolutionizing the conventional practices of the construction industry and has reinforced the impact of the design process on the building project's overall lifecycle. This paper proposes a BIM-based evaluation system to provide a comprehensive and standardized approach for assessing the sustainability of green buildings with respect to local construction material usage. The system involves applying alternative combinations of building materials to BIM models and analyzing them to determine embodied energy and greenhouse gas (GHG) emissions. The results show that using locally available construction materials generally results in lower carbon emissions and higher recyclability, as well as reduced fuel consumption associated with transportation and raw material extraction. These findings contribute to advancing green building practices by promoting the use of local materials and reducing environmental impacts. The proposed system can assist architects, engineers, and other stakeholders in making informed decisions during the design and construction phases, thereby fostering the development of more sustainable buildings and informing revisions to green rating system labels.

Keywords: Local Construction Materials; Green Building; Carbon Emission; Life Cycle Analysis; Building Information Modelling

ICSBE24_108

EVALUATING THE POTENTIAL OF ARTIFICIAL INTELLIGENCE IN AUTOMATING CONTRACT ADMINISTRATION

Manoj Mudiyanselage*, Pushpitha Kalutara, Kumaran Suntharavadivel, Chamil Erik Ramanayake

School of Engineering and Technology, Central Queensland University, Rockhampton, QLD 4701 Australia

**Correspondence E-mail: 12186273@cqumail.com, TP: +61413815031*

Abstract: Effective and efficient contract management is critical to successful project delivery. Nevertheless, traditional contract administration workflows face many challenges due to lack of efficiency and repetitive tasks; compliance and risk management issues; labor intensive nature; slow and sub-optimal digitalization; and widespread fragmented data management practices. To provide a holistic solution to these issues, thus, this research investigates the potential of Artificial Intelligence (AI) to automate the contract administrator's duties and responsibilities. This study employed a systematic literature review and a desktop review to test the benefits of AI while using it with a security-minded approach to data privacy. This research finds that AI application could improve contract administration functions by enhancing data quality, data security, and seamless data integration. With the integration of a blockchain technology called Smart Contracts, AI could assist with improved decisions via data-driven recommendations supported by real-time report updates, automated payments and milestones, prompt alerts and calendar automation. To increase AI uptake in construction contract administration, strategies must be crafted and implemented to increase industry awareness and readiness.

Keywords: Artificial Intelligence; Contract Administration; Reporting; Automation; Decision-making

ICSBE24_334

TYRE-WASTE DERIVED GRAPHENE OXIDE IMPACT ON CEMENT MORTAR: A STUDY OF MECHANICAL AND MICROSTRUCTURAL CHARACTERISTICS

W.C.H. Silva[1], M.A. Zafar[1], M.V. Jacob[1], R. Tuladhar[2*]
[1]*College of Science and Engineering, James Cook Univeristy, Townsville, QLD 4811, Australia*
[2]*School of Engineering and Technology, CQUniversity, QLD 4701, Australia*
**Correspondence E-mail: r.tuladhar@cqu.edu.au, TP: +61488185953*

Abstract: The utilisation of waste materials for sustainable development has gained considerable attention in recent years, particularly in the synthesis of carbon-based nanomaterials such as Graphene Oxide (GO) from agricultural and industrial waste. Among these wastes, discarded tyres present significant environmental challenges, highlighting the necessity for efficient recycling methods. Tyre char, a byproduct of tyre pyrolysis, contains carbonaceous components suitable for conversion into GO. The exploration of waste-derived GO opens promising avenues across various applications. GO has garnered significant interest for its use as nano-reinforcement in cement composite due to its exceptional mechanical properties and active functional groups. This study investigates the impact of tyre-waste derived GO on the mechanical and microstructural properties of cement mortar. Microwave-Assisted Pyrolysis (MAP) stands out as a preferred method, offering efficiency, effectiveness, and minimal environmental impact. The MAP process converts the tyres into char, which is further treated to develop GO and is analysed using various techniques including XRD, Raman spectroscopy, SEM, TEM, XPS, and FTIR. A comprehensive Life Cycle Assessment (LCA) will be conducted to evaluate the environmental impact of the GO production process. The synthesised GO is then incorporated into cement at different dosages to identify its effects on mechanical and microstructural properties. The mechanical properties including compressive and flexural strength are examined. Additionally, microstructural analysis techniques such as SEM and XRD are used to evaluate the morphological changes and hydration products within the cement mortar matrix. This research highlights the potential of tyre char-derived GO as a viable solution for enhancing cement mortar properties, contributing to sustainable practices in the construction industry.

Keywords: Graphene Oxide; Cement; Tyre Char; Microwave Assisted Pyrolysis; LCA

ICSBE24_171

IMPACT OF JOB LOSSES ON LARGE SCALE CONTRACTORS IN 2022-2023 ECONOMIC CRISIS IN SRI LANKA

D.A.R. Dolage*, K. Tharanga
The Open University, Colombo, Sri Lanka
**Correspondence E-Mail: dadol@ou.ac.lk, TP: +94112513023*

Abstract: There is no clear knowledge about the variation of the number of professional and trade employees over the last 10 years and the activities that get affected most due to the job losses during the economic crisis, and thereby impacting on the project. Since the impact is a broad concept, in this study, the impact is considered to have three aspects namely; Impact on 'on-time' project completion, Impact on quality of work and Impact on construction cost. The variation of both trade and professional employees is marginal over the period from 2013 until the end of 2017 but a sharp decline in job losses was observed after 2018 with respect to most large contractors. This decline can be attributed to various reasons such as economic recession, the Easter Sunday attack, the Covid-19 pandemic, the recent economic crisis and political uncertainty. The above stated external factors have continued to harm the industry, resulting in a reduction of employment approximately by 50 % from the figures in 2018. It can be concluded that over the years 2018 - 2022 all the large contractors have either cut jobs or lost employees due to the attrition. The critical activities affected by job losses during the economic crisis are presented below; Impact on 'on-time' project completion: Procuring construction material 'on time using professional employees'; Getting approval for the variation orders 'on time' using professional employees'; Preparing interim bills 'on time; using professional employees' Impact on quality of work: Keeping to the agreed curing and deshuttering schedule by professional employees; Keeping to the agreed curing and deshuttering schedule by trade employees; Conducting necessary sampling and testing by trade workers. Impact on construction cost: Completing the project below the estimated overhead cost using trade employees; Preparation of accurate interim bills using professional employees; Preparation of tender submissions and contractual claims using professional employees. Since the critical activities have been identified, actions can be taken to mitigate the negative impact.

Keywords: Construction Industry, Impact of Job Losses; Economic Crisis, Large Scale Contractors

ICSBE24_071

IMPACT OF HEALTH AND SAFETY COSTS ON BUILDING CONSTRUCTION COSTS IN SRI LANKA

Induja Gunathilake[1], Chamari Allis[1], Kavini Guruge[2*]
[1]Deaprtment of Quantity Surveying, Faculty of Engineering,
Sri Lanka Institute of Information Technology, Malabe
[2]Department of Building Economics, University of Moratuwa, Katubedda
**Correspondence E-mail: kaviniveenadhi1997@gmail.com, TP: +94770406253*

Abstract: The nature of construction projects makes the construction industry riskiest and more hazardous by increasing mortality and morbidity rates. The Sri Lankan construction industry ranks low in health and safety management at the site. Investment in health and safety programs significantly improves the overall construction project, and it has influenced organisational individuals to neglect the relevant activities relating to accident-preventing activities at construction sites. This study presents the impact of health and safety costs on building construction costs in Sri Lanka by using cost data from previously completed high-rise building construction projects in Sri Lanka. This study aims to identify the impact of health and safety costs on the total construction project sum. A qualitative research approach has been carried out to achieve the research objectives: to identify the elements of health and safety programs used to forecast the health and safety cost of the projects, secondly to identify the most relevant to each aspect of health and safety programs identified, and finally to determine the relationship between health and safety cost and construction cost. A literature survey was conducted to fulfil the first objective, and the second and third objectives were achieved through expert interviews using semi-structured questionnaires. Manual content analysis was used to analyse the data collected. Finally, the study revealed a positive relationship between the construction cost and the project's health and safety prevention cost. It is recommended that the proper way to cost the health and safety prevention program is to adhere to eliminating unnecessary cost incensements.

Keywords: Construction Industry; Cost Elements; Health and Safety Elements; Safety Management

ICSBE24_082

EXPERIMENTAL STUDY ON THE SWELLING CHARACTERISTICS OF RECYCLED CONSTRUCTION SLUDGE IN SULFATE-RICH ENVIRONMENTS

K.R. Withanage[1*], K. Hayano[2]
[1]*Graduate School of Urban Innovation, Yokohama National University, Yokohama, Kanagawa, Japan*
[2]*Faculty of Urban Innovation, Yokohama National University, Yokohama, Kanagawa, Japan*
**Correspondence E-mail: kapila593@gmail.com, TP: +94718495487*

Abstract: Swelling may occur in stabilized treated soil when exposed to a sulphate environment. particularly in road subgrade and embankments are susceptible to sulphate ion penetration when there is water seepage, Sulphate-containing fertilizer is practically being used by agricultural land users near the treated subgrade roads or embankments. This study uses the swelling test of stabilized soil and Na_2SO_4 solutions to present the impact of sulphate attack on treated soil. As per the Japanese standard, swelling tests were performed using the California Bearing Ratio (CBR) test apparatus. Soil removed during construction projects, especially from excavation efforts in pile and tunnel construction, is referred to as surplus soil which is called construction sludge in Japan. Treated soil was created by combining construction sludge (Ao clay) with paper sludge ash-based stabilizer (PSAS) (20 %) and blast-furnace cement type B (BFCB) (3 %) with respect to different initial moisture conditions. To illustrate the effect of sulphate, the samples that were submerged in sodium sulphate solution, whereas the non-sulphate test samples were left unaltered. In order to determine the strength parameters, samples experienced a cone resistance test, with temperature and pH levels also taken into account. The production of ettringite in the secondary stage due to excessive swelling of treated soil was identified using SEM images. Furthermore, substances like hydrates, silicate, and calcium also have a significant influence on how ettringite forms. These findings will aid the construction sector in overcoming its obstacles, as initial moisture content is a key factor in regulating swelling.

Keywords: Swelling; Sulphate; Treated Soil; SEM

ICSBE24_122

INVESTIGATE THE PERFORMANCE OF PAD FOOTING WITH THE USE OF CONTROLLED MODULUS COLUMN (CMC) AS A GROUND IMPROVEMENT TECHNIQUE

D.C. Hondamuni*, H.G.H. Damruwan, L.I.N. De Silva
University of Moratuwa, Bandaranayake Mawatha, Moratuwa 10400
**Correspondence E-mail:chandeepadhyan@gmail.com, TP: +94714890902*

Abstract: When constructions are carried out on weaker/Soft soils, several structural and ground improvement techniques such as the use of larger footings, piles, micro piles, Controlled Modulus Column (CMC), and concrete cylinders with filling materials are used in practice. The CMC technique, which is based on a load-sharing system between the soil and the columns, is used to fill the gap between more expensive pile solutions and classical soil improvement techniques. However, despite its increasing use in Europe and North America, there is a limited understanding of the effectiveness of this technique in domestic building construction. This research has investigated the performance and adequacy of this technique by using the MIDAS GTS NX Finite Element (FE) analysis software. Column footing, soil, and CMCs were modelled in three dimensions (3D). The soft clay soil was modelled using Mohr-Coulomb and Modified Cam Clay soil models to obtain both immediate settlements and consolidation settlements. Mesh sensitivity analysis and validation processes were carried out to determine the optimum mesh sizes and to increase the accuracy and efficiency of computational works. A comprehensive study was carried out with developed models to investigate the influence of CMCs in reducing both immediate settlements and consolidation settlements. This study provides a more comprehensive understanding of the CMC technique's performance in reducing settlements, improving bearing capacity, and improving soil-structure interaction, providing valuable information on this technique's adequacy as a more economical ground improvement solution for domestic buildings on clay soils. Additionally, the comprehensive models developed in this study can be utilized in future research for parametric studies and the exploration of various ground improvement techniques. These models will offer insights into enhancement methods, enabling necessary improvements when constructing residential buildings on weak soils. This approach has the potential to reduce costs while simultaneously enhancing structural stability.

Keywords: Footing; Settlements; Bearing Capacity; Ground Improvement; Finite Element Analysis

ICSBE24_132

ENTERPRISE RESOURCE PLANNING SYSTEM FOR ROAD CONSTRUCTION PROJECTS IN SRI LANKA

V. Lingasabesan*, M.D.T.E. Abeynayake, L. Shadurshaan
Department of Building Economics, University of Moratuwa, Katubedda, Sri Lanka
**Correspondence E-mail: vithushal@uom.lk, TP: +94778428499*

Abstract: Roads promote the country's economy and make life easier for its citizens. The research offers a novel perspective on the synergy of Enterprise Resource Planning (ERP) and road construction projects in the Sri Lankan context, which is a relatively under-researched area where investigation is needed for better understanding. The purpose of the research is to enhance the Sri Lankan Road projects through the ERP system. A mixed research approach, along with an extensive literature review, has been conducted to pursue the aim of the study. A questionnaire survey and expert interview were conducted to carry out the data collection process, and the data was analyzed using the RII technique and content analysis respectively. Findings revealed that a few contractor organizations are already practicing the ERP system for road construction projects, which is used for building construction. There is a lack of customized ERP software for road construction projects in Sri Lanka. The study ranked the barriers to implementing ERP systems in road construction projects in Sri Lanka. Findings showed that the significant barriers to not implementing ERP systems in road construction organizations are resistance to change into innovative concepts by senior management of the organization, poor quality of testing, lack of project management methodology, considerable implementation time, implementation cost, insufficient training of end users and failure to get user support. Further, this study proposed strategies to overcome the barriers. Implementing customized ERP software would be a worthwhile initiative for road projects in Sri Lanka. The findings of this study would be beneficial for a construction enterprise that is required to implement the ERP for the first time. Further, the study would help construction enterprises make sound decisions related to ERP systems in their organizations; thus, this is the novelty of this study. This study was conducted in a developing country and will be an excellent reference study in the future.

Keywords: Construction Projects; Enterprise Resource Planning; Road; Sri Lanka

ICSBE24_127

THE FUTURE OF FACILITIES MANAGEMENT IN THE CONTEXT OF INDUSTRIAL REVOLUTION 4.0

E.D.M.E.M. Dhanapala[1*], P. Sridarran[2], S. Thirumal[3]
[1]Department of Building Economics, University of Moratuwa, Sri Lanka
[2]Department of Facilities Management, University of Moratuwa, Sri Lanka
[3]School of Architecture and Built Environment, Deakin University, Australia
**Correspondence E-mail: erandidhanapala1219@gmail.com, TP: +94766397828*

Abstract: Facilities Management (FM) industry has been recently placed a greater emphasis on adding value to organisational functions through the development and adoption of innovative technology. FM need to use novel technology to adapt to the concurrent technological environment and embrace the best practices for organisations. The Fourth Industrial Revolution is a concept that is at the pinnacle of technological development. The significant backwardness in the industry for such remarkable technological evolutions inspired this study to analyse the adaptability of Industrial Revolution 4.0 (I4.0) to the current FM industry in Sri Lanka. The required and current adaptability levels of I4.0 towards FM competencies were determined using expert surveys and questionnaire surveys respectively. The result shows that Operation and Maintenance and Health and Safety as the most satisfactory FM competency which has gained more potential to adapt to I4.0. Thereupon, the gap between the two levels was analysed with the descriptive statistical analysis method. The gap analysis was mainly conducted with the prerequisites which involve higher required levels. Thereby, critical lagging prerequisites were identified, affecting the gap between the current and the required I4.0 adaptation in organizations. Ultimately, the study provides strategies to enhance the adaptation of I4.0 whereas collaboration among the community, raising educational awareness, and Research and Development (R&D) concluded as the most ideal actions.

Keywords: Industrial Revolution 4.0; Facilities Management Competencies; Industry 4.0 Prerequisites; Strategies

ICSBE24_037

SUGARCANE BAGASSE ASH AS A PARTIAL REPLACEMENT OF CEMENT IN MASONRY BLOCK PRODUCTION

T.A.H.N. Piyarathna*, I.S.K. Wijayawardane, T.M. Pallewatta
Department of Civil Engineering, The Open University of Sri Lanka, Nawala, Nugegoda
**Correspondence E-mail: harshanipiyarathna1234@gmail.com, TP: +94768556218*

Abstract: In Sri Lanka, the escalating cost of cement-based construction materials has prompted the search for cost-effective and sustainable alternatives. This study investigates the preliminary study on Sugar Cane Bagasse Ash (SCBA) to partially replace cement in masonry blocks. SCBA has a high SiO_2 content (around 85 %), hence exhibits enhanced pozzolanic properties. In this study mortar cubes (100 mm × 100 mm × 100 mm) and cuboids (40 mm × 40 mm × 160 mm) were cast with varying cement replacement levels (0 %, 5 %, 10 %, 15 %, and 20 %) to test compressive and flexural strengths at 7 and 28 days to explore the optimal ash replacement range for block production. Additionally, water absorption and density of the cement mortar were studied. Mortar was mixed with a 1:6 cement-to-sand ratio and 0.7 water-to-binder ratio. Results showed that SCBA was more effective at enhancing the mechanical properties of mortars at 5 % of cement replacement level. Further, the 10 % replacement of cement with SCBA resulted in a marginal decrease in strength compared to the control sample and beyond the 10 % replacement, there was a notable decrease in strength at higher replacement levels, 15 % and 20 %. Higher SCBA content also increased the water absorption and slightly reduced the density. Replacing 5 % of cement with SCBA resulted in a 2.87 % reduction in cost per meter cube of mortar while a 10 % replacement of cement resulted in a 5.77 % of cost reduction.

Keywords: Sugarcane Bagasse Ash; Cellular Masonry Bocks; Supplementary Cementitious Materials; Pozzolanic Activity

ICSBE24_200

EPITOMIZE THE RELATIONSHIP BETWEEN BOND PARAMETERS AND SHEAR STRENGTH OF CFRP/CONCRETE COMPOSITES

S.M.A.L.K. Sammandapperuma[1*], E.R.K. Chandrathilaka[1], Samiru Gayan[1], Kumari Gamage[2]

[1]Univesity of Moratuwa, Moratuwa, Sri Lanka
[2]Engineering Institute of Technology, Brisbane Campus, Adelaide Street, QLD4000, Australia
**Correspondence E-mail:sammandapperumasmalk.24@uom.lk, TP: +94718111799*

Abstract: The use of Carbon Fiber Reinforced Polymer (CFRP) for the strengthening and restoration of concrete structures has gained a significant rise in recent years. The effectiveness of CFRP as a strengthening material is highly dependent on the quality of the bond between the CFRP and the concrete substrate. Extensive research has been conducted on evaluating bond performance for a variety of geometries and materials. However, the identification of variations in bond performance with respect to bond sensitive parameters, such as geometric dimensions of the bond and material properties of CFRP, epoxy and concrete, will provide clear guidance to strengthen future applications. A comprehensive data set was collected from previous studies on bond shear performance. The data was analyzed for critical bond parameters. The results emphasized the importance of careful design considerations when implementing CFRP systems in concrete structures. Considering future development, integrating Machine Learning (ML) approaches to enhance the understanding of these complex interactions is highlighted.

Keywords: Carbon Fibre Reinforced Polymer; Concrete Strengthening; Bond Strength; Critical Parameters; Interface Characteristics

ICSBE24_066

STRATEGIES TO IMPROVE HOUSEHOLD WASTEPAPER RECYCLING IN SRI LANKA

M.H.S. Priyalal[1], A.S.W. Karunarathna[2*], R.M.N.U. Rathnayake[2]
[1]Department of Building Economics, University of Moratuwa
[2]Department of Facilities Management, University of Moratuwa
**Correspondence E-mail: sandunik@uom.lk, TP: +94712289040*

Abstract: Although digitalization is expected to decrease paper consumption, it is still on the rise for different use cases, such as printing or packaging, around the globe. Poor waste management specially in the urban regions has increased the environmental and public health problems within Sri Lanka. Recycling is an achievable way to reduce these problems and is an important part of the 3R (Reduce, Reuse, Recycle) concept. This research highlights the potential of recycling Sri Lankan household paper waste as a sustainable solution to address the ongoing challenges of waste management and the paper shortage crisis affecting the nation. A mixed-method approach was adopted to assess current ways in which residents dispose their waste, level of awareness and the problems encountered in paper recycling. It included a survey of 103 dwellings and interviews with garbage collectors and recycling professionals. Written paper, newspaper, and hardboard were found to be the most commonly existing form of the domestic wastepaper with the most common disposal method is open burning. The relationship between household size and paper waste disposal has been a topic of interest in this study, as it may provide insights into factors influencing waste generation patterns. Additionally, the awareness and engagement in recycling practices were evaluated for promoting sustainable waste management strategies. Regional variations in disposal methods further highlight the need to examine local practices and preferences in waste handling. Recycling is effectively recognized however actual engagement is still less due to various factors such as inadequate collection services, less monetary rewards. The paper provides analytical insights about strategies for promoting paper recycling, such as increasing collection systems, building recycling infrastructure, and raising public awareness.

Keywords: Household Paper Waste; Waste Management; Paper Recycling; Recycling Strategies

ICSBE24_154

ASSESSING HAZARDOUS WASTE MANAGEMENT PRACTICES IN KATUNAYEKE, BIYAGAMA, AND SEETHAWAKA EXPORT PROCESSING ZONES IN SRI LANKA

M.K.D.K.C. Madapatha[1*], S. Herat[2]
[1]Griffith University, Queensland 4111, Australia
[2]Associate Professor, Griffith University, Queensland 4111, Australia
**Correspondence E-mail: s5401021@griffithuni.edu.au, TP: +61466812707*

Abstract: The Export Processing Zones (EPZs) in Katunayake, Biyagama, and Seethawaka, Sri Lanka, managed by the Board of Investment (BOI) of Sri Lanka, generate significant hazardous waste, primarily from the textile and rubber industries. Despite each zone producing more than 7,500 tons of hazardous waste annually, waste management options are limited. Currently, only INSEE Eco cycle's cement kiln co-incineration facility has the Central Environmental Authority's (CEA) approval to handle hazardous waste. As future hazardous waste generate will not come from new industries since most of the lands are already utilized, the expansion of centralized wastewater treatment capacities in these zones will increase production capacity of existing industries, and consequently, hazardous waste output. Projections suggest that hazardous waste will increase to 12,000 MT annually from both Katunayake and Biyagama, and 10,500 MT from Seethawaka in near future. Current challenges include the monopolistic waste management system, leading to high costs, storage issues, and transportation issues. The lack of pre-processing facilities in Biyagama and Seethawaka, and INSEE's limited ability to handle certain waste types, increase these issues. This study highlights the urgent need for enhanced waste management practices, the necessity of introducing a comprehensive data recording system to monitor hazardous waste generation and investments on further research to address the growing demand for hazardous waste management.

Keywords: Hazardous Waste; Board of Investment; EPZ; Sri Lanka

ICSBE24_123

EVALUATING THE VIABILITY OF RENEWABLE ENERGY SOURCES IN SRI LANKA: IMPLICATIONS AND OPPORTUNITIES

I.S.M. Kankanamge*, A.H.K.K. Pathmadewa
General Sir John Kotelawala Defence University, Kandawala Road,
Rathmalana, P.O. Box: 10390
**Correspondence E-mail: induneth.salaka@gmail.com, TP: +94773331330*

Abstract: This research examines the gap between the theoretical potential and the actual implementation of renewable energy sources in Sri Lanka, emphasizing the technological, economic, sociocultural, and policy-related obstacles that hinder their full utilization. The objective of the study is to conduct a comprehensive analysis of the factors influencing the adoption of renewable energy, particularly in the context of addressing climate change and facilitating global sustainable energy transitions. Engaging a qualitative research approach, data were gathered through semi-structured interviews with a purposefully selected group of 25 participants from renewable energy firms and governmental bodies. The renewable energy companies represented sectors such as solar energy, mini hydropower, and biogas. Government representatives included officials from the Ceylon Electricity Board, Sri Lanka Sustainable Energy Authority, Sri Lanka Atomic Energy Authority, Urban Development Authority, Ministry of Environment, and Ministry of Energy. The data were analyzed using thematic analysis. The findings indicated that the main obstacles to the adoption of renewable energy technologies include high initial costs, insufficient technical expertise, difficulties in obtaining financing, inconsistent regulatory frameworks, and a lack of public support, along with opposition to projects that necessitate land acquisition or relocation. These challenges remain despite the recognized benefits of renewable energy, such as reduced greenhouse gas emissions, enhanced energy security, job creation, and technological progress. This study contributes valuable insights into the socio-economic and environmental factors that affect the adoption of renewable energy in developing nations, with a particular emphasis on Sri Lanka. It also provides evidence-based recommendations for improving the integration of renewable energy sources. Future research should focus on conducting comparative assessments of various renewable technologies.

Keywords: Renewable Energy Adoption; Sustainable Energy; Energy Policy; Challenges for Renewable Energy Adoption; Sri Lanka

ICSBE24_140

HYDRAULIC LOSS ANALYSIS OF PUMP TURBINE ACCORDING TO THE SPECIFIC SPEED IN TURBINE MODE

Ujjwal Shrestha[1], Prasanna Gunawardane[2], Young-Do Choi[3*]

[1]Graduate School, Department of Mechanical Engineering, Mokpo National University, 1666 Youngsan-Ro, Cheonggye-Myeon, Muan-Gun, Jeonnam, 58554, Republic of Korea

[2]Department of Mechanical Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya 20400, Sri Lanka

[3]Department of Mechanical Engineering, Institute of New and Renewable Energy Technology Research, Mokpo National University, 1666 Youngsan-Ro, Cheonggye-Myeon, Muan-Gun, Jeonnam, 58554, Republic of Korea

**Correspondence E-mail:ydchoi@mnu.ac.kr, TP: +82614502419*

Abstract: Hydropower is a clean energy which reduces the consumption of fossil fuels. Pumped storage hydropower is the solution of storing electric energy (pump mode) and generating electricity (turbine mode) to meet the power grid demand for flexible regulation. The pump turbine impeller is the core equipment of pumped storage hydropower, which directly influences the performance of the pump turbine system. The pump turbine impeller shape design is related to the specific speed of the pump turbine. With the increasing significance of pumped storage in the power system, there is a growing emphasis on improving the hydraulic performance of pump turbines at off-design conditions. When the pump turbine operates at the off-design conditions, hydraulic losses in the pump turbine components increase significantly. The theoretical and numerical analysis was used to evaluate the hydraulic losses of the pump turbine components in turbine mode. The magnitude of hydraulic losses varies according to the operating conditions and impeller shape design. Hence, the hydraulic losses in the pump turbine components are calculated based on specific speeds and flow conditions. Pump turbines with specific speeds (N_S) 30 and 55 are designed to evaluate the hydraulic loss at various flow conditions. At partial and high flow rates, the hydraulic loss in each specific speed pump turbine is significantly higher than the best operating point. Especially in this study, at partial flow rate, the N_S =55 pump turbine showed a comparatively lower loss magnitude than that of the N_S =30 pump turbine in turbine mode.

Keywords: Pump Turbine; Loss Analysis; Specific Speed; Turbine Mode; Off-design Range

ICSBE24_022

CONVERTING EXISTING DIESEL ENGINE INTO BIODIESEL ENGINE

W.D.L. Thissera*, M.M.D.J. Paris, R.M.C.S. Rathnayake, V. Madhushan, Y.V. Madusanka, V.K.D. Wijesekara

University of Jaffna, Department of Engineering Technology, Faculty of Technology, Araviyal Nagar, Kilinochchi 44000, Sri Lanka

**Correspondence E-mail: 2019ET088@tech.jfn.ac.lk, TP: +94704533889*

Abstract: During the 21st century, global energy demand has increased rapidly as a result of economic and social development. Fossil fuels account for approximately 84% of global total primary energy consumption. Reliance on fossil fuels to meet these energy needs has become a serious problem as fossil fuel reserves are rapidly depleting. Hence, the need for alternative fuels such as biodiesel arises here. Biodiesel is a good renewable fuel that can be used instead of diesel. The need of this project is to reduce the dependence of countries on fossil fuels by adapting to the use of biodiesel, reduce environmental pollution caused by emissions, and boost the economy by developing more sustainable alternatives to some of the identified problems. The ultimate goal of this study is to convert an existing diesel engine into a biodiesel engine with acceptable performance and efficiency. For this, a Kubota K75 engine (4-stroke, 375 cc, 2540 rpm, single-cylinder, direct injection, water-cooled engine) and diesel & biodiesel blend compositions (B10, B20, B30, B40, B50, B60, B70 and B80 compositions) are used. The data related to engine performance, emission, wear, and vibration are collected and evaluated. In addition, the chemical properties of pure diesel & biodiesel blends are also evaluated by conducting tests such as viscosity test, flashpoint test, etc. After analyzing the collected data, the most suitable biodiesel composition is suggested from B50 to B80 compositions. In relation to that, develop and replace the necessary parts of the engine and related components, and also optimize the bio-diesel engine's performance and emissions. Moreover, a development is done in the engine mount to minimize the excessive vibration caused by the engine. The desired outcome of the research is to achieve the same performance as a conventional diesel engine with very minimal emissions from an engine using biodiesel as fuel.

Keywords: Bio-diesel; Engine Performance; Engine Emission; Engine Wear; Engine Vibration; Fuel Blends

ICSBE24_96

IMPACTS OF WEATHER CONDITIONS IN PV SOLAR ENERGY PRODUCTION – AN IOT BASED MONITORING AND FORECASTING SYSTEM

A.A.S. Suja[1*], A.L.F. Sasna[1], M.N.M. Aashiq[2], A.M.A. Saja[1], W.G.C.W. Kumara[2]
[1]Department of Electrical and Electronic Engineering, Faculty of Engineering, South Eastern University of Sri Lanka
[2]Department of Computer Science and Engineering, Faculty of Engineering, South Eastern University of Sri Lanka
**Correspondence E-mail: ahamedsarothsuja@gmail.com, TP: +94766786140*

Abstract: This study investigated the interdependent impacts of dynamic weather parameters, namely temperature, humidity, and light intensity on solar energy production and developed a model to monitor and forecast PV solar energy production. This research employed an Internet of Things (IoT) based monitoring system to capture real-time weather data and integrated it with solar energy production monitoring and forecasting. The proposed system allows for real-time adjustments to maximize solar energy harvesting efficiency, paving the way for smarter and more responsive solar energy production. The proposed IoT system includes a weather station, sensors, and a 10W solar panel, which records vital weather parameters and real-time solar energy generation data which was processed and stored in the Thing Speak cloud platform. The IoT system enables rapid informed decision-making thus optimizing solar energy production strategies. The data analysis from the developed prototype revealed that the Random Forest Model is the best forecasting model for this type of system. The optimization model that was developed in this study using real-time data can help to predict and thus, maximize the energy output from solar systems based on varying weather conditions.

Keywords: Smart Energy Management System; Internet of Things; Solar Harvesting Monitoring; Interactive Data Analysis; Weather Condition; Random Forest Model

ICSBE24_139

METHODOLOGICAL FRAMEWORK FOR DEPLOYMENT OF HYDRO TURBINES TO RECOVER EXCESS ENERGY FROM PIPE-BORNE WATER SUPPLY SYSTEMS IN SRI LANKA

M.A.I.A. Moragoda*, S.B. Weerakoon
Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: isurunimoragoda@gmail.com, TP: +94711477774*

Abstract: The sustainability of the water supply sector is particularly crucial due to the high costs and energy demands of water treatment and distribution. One promising strategy to make pipe-borne water supply systems energy efficient involves recovering excess energy in water distribution systems by integrating micro-turbines into existing Pressure Reducing Valves (PRVs). This strategy not only enhances the sustainability of water supply networks but also reduces GHG emissions. This research aims to evaluate the technical and economic feasibility of generating hydro energy by installing in-conduit micro-hydro turbines in Sri Lanka's Water Distribution Networks (WDNs). A technical evaluation criterion identifies optimal PRV locations for micro-hydro turbine installation, while economic feasibility is assessed through cost-benefit and sensitivity analyses. The methodology is demonstrated through a case study of the Kandy-North Pathadumbara Integrated Water Supply Project, which involves the installation of 85 PRVs. The analysis includes a cost-benefit comparison of using different turbine types. The study reveals that it is optimal to integrate 20 micro-turbines of capacities ranging from 1.5 kW to 8.5 kW into proposed PRV locations. The resulted total installed capacity of these turbines ranges between 53–65kW and can generate around 292-360 MWh of energy per year. Based on the results of the study, guidelines for installing turbines in WDNs are provided. This methodological framework serves as a model for similar initiatives aimed at enhancing sustainability and energy efficiency in water distribution networks through hydro-energy recovery.

Keywords: Sustainable Water Supply; Water-energy Nexus; In-conduit Micro-hydro Turbines; Water Distribution Systems; Green Energy Economics

ICSBE24_690

ELECTROLYSIS-INDUCED INSITU COAGULANT FOR TURBIDITY REMOVAL

W.A.M. Weerasinghe[1], N.A.P.M. Nishshanka[1], S.K. Weragoda[2], A.A.G.D. Amarasooriya[1*]

[1]Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Sri Lanka

[2]Joint Research and Demonstration Center for Water Technology Ministry of Water Supply, Peradeniya

**Correspondence E-mail: gayan.a@uwu.ac.lk, TP: +94761026772*

Abstract: Surface water is a common source of drinking water worldwide. One of the major problems associated with surface water is turbidity, which makes treatment more difficult and requires effective solutions. The most common method for treating turbidity is coagulation, which requires the use of additional chemicals. However, for developing countries, importing these high-cost chemicals are challenging due to ongoing economic crises. In this context, the in-situ generation of coagulants presents a viable solution, allowing for effective water treatment without the need for costly external chemicals. This study investigated an innovative in-situ solution: electrolysis-induced coagulation synthesis for effective turbidity removal. The experimental methodology utilized an electrolysis setup with aluminium electrodes as the anode and stainless-steel electrodes as the cathode. The dissolved aluminum ions from the anodes act as coagulants, enhancing suspended particle collection. When aluminum ions are the only component used, the coagulation mechanism is more focused and direct, increasing efficiency and preventing the addition of extraneous materials to the treated water. High removal efficiencies have been observed in the study across different initial turbidity levels, commonly exceeding 85 % and frequently achieving rates as high as 98 %. The 150 mA is considered the best current after considering the best possible trade-offs between pH stability, turbidity removal efficiency, and residual aluminium concentration. Based on the initial and final turbidity levels, the best pH range for reducing turbidity was 6.5 to 8.5. The technique shows some instability at low initial turbidity levels, indicating that higher turbidity levels may be the most effective conditions under which the method works. The approach not only offers a technically strong and effective way to remove turbidity, but it also addresses the growing need for water treatment technologies that are both economically and environmentally feasible.

Keywords: Turbidity; Aluminium Electrolysis; Coagulant; Residual Aluminium; Stainless Steel

ICSBE24_241

GROWTH OF NOVEL NANOSIZED METATITANIC ACID: A VALUE ADDITION TO NATURAL ILMENITE

S.T. Jegapragashan, A.H. Janaka Sampath, K.M. Nalin de Silva, Rohini M. De Silva*

Centre for Advanced Materials and Devices (CAMD), Department of Chemistry, University of Colombo, Colombo 00300, Sri Lanka

**Correspondence E-mail: rohini@chem.cmb.ac.lk, TP: +94714406263*

Abstract: Being an unexplored yet essential Titanic Acid, Metatitanic acid (MTA, H_2TiO_3) holds great potential for exploration in research. Micro-scaled MTA can be readily extracted from ilmenite through a novel process recently developed by our research group. This research mainly focused on synthesizing nano-MTA and modifying it with nitrogen, particularly for MTA endowed with enhanced photocatalytic activity. The synthesis of nano-MTA was achieved by introducing surfactants to the particle formation stage of the original process. For this purpose, three surfactants, i.e., Cetyltrimethylammonium bromide (CTAB), Sodium Dodecyl Sulfate (SDS) and Polyethylene Glycol (PEG) 6000, representing cationic, anionic and polymeric surfactants, respectively, were used, where Ti4+ to surfactant molar ratio was maintained as 1: 2 and 1: 3. Scanning Electron Microscopic (SEM) images revealed that MTA produced using SDS appeared as microscopic plate-like structures (300 nm – 400 nm) and particles were highly agglomerated. However, comparatively smaller MTA particles, in the range of 100 nm – 300 nm, were obtained when CTAB was used as the surfactant, where the particle agglomeration was also minimal compared to the product obtained through SDS. However, PEG 6000, in three times molar ratio with respect to Ti^{4+}, resulted in the smallest MTA nanoparticles in the range (100 nm -150 nm) with a lower particle agglomeration and better particle size distribution. Nano-MTA was subsequently treated hydrothermally with urea to modify the compound with nitrogen. The photocatalytic activity of N-treated MTA was then assessed and compared with that of micro-MTA and nano-MTA in terms of degrading the Methylene Blue (MB) dye under ultraviolet (UV) irradiation. The results exhibited a significant enhancement in the photocatalytic activity of the N-treated nano-MTA compared to the other two species, achieving a dye degradation efficiency of 95.75 %.

Keywords: Metatitanic Acid; Ilmenite; Surfactant; Photocatalytic Activity; Agglomeration

ICSBE24_102

OPTIMIZING RESOURCE USE EFFICIENCY IN GREEN BUILDINGS: A SYSTEMATIC REVIEW OF SUSTAINABLE WATER MANAGEMENT, ENERGY EFFICIENCY, AND ENVIRONMENTAL IMPACT

R.H.N.S. Rathnapriya[1*], H.A.T.N. Perera[2], G.Y. Jayasinghe[1]
[1]*Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Matara-Kamburupitiya Rd, 81100, Sri Lanka*
[2]*Department of Environmental Engineering, Faculty of Earth Science and Environmental Engineering,University of Miskolc, 3515,Miskolc,Hungary*
**Correspondence E-mail:* rathnapriya4gt@ags.ruh.ac.lk*, TP: +94703071163*

Abstract: Green buildings are critical in meeting the ever-growing global needs for water and energy by using sustainable building design and technologies to mitigate the factors that contribute to these demands of increasing world population, urbanization, and emerging climate change. This paper will provide an overall evaluation of (a) different water management practices for green buildings, (b) analysis of technologies that improve energy functionality, (c) assessment of environmental outcomes associated with sustainable measures, and (d) useful practices and unique solution searching for efficient resource usage. Conducted from 2000 to 2024, PRISMA methodology, along with Google Scholar and ResearchGate databases, and jointed Boolean logic gates (AND, OR) were used to review; most related 20 studies out of 1,156 after a screening process aligned on inclusion-exclusion criteria on incorporating keywords of "sustainable construction", "green building techniques", "energy-water efficiency", "sustainable water management", and "environmental impact". Most studies (33 %) stated that water consumption among buildings could be reduced by 90 % by sustainable construction and green building techniques, enhanced energy-water efficiency by 80 % to lead sustainable water management, green buildings also offer a significant greenhouse gas emissions reduction on CO_2, NO_x, SO_X respectively 24 %, 13 %, and 9 %, to playing a part in climate change. The energy utilization is reduced by 40-50 % with LEED, BREEM certified green buildings (LEED, BREEM), moreover; it has an average water usage reduction of 37 %. These include understanding more about hydrophilic treated photovoltaic (PV) panels, and utilizing Building Information Modelling (BIM), systems for renewable energy, and studying areas on the water-energy nexus and future cooling technologies. The implications of the integration of water management need to focus on systems engineering, digital twin technologies, and water-energy-waste optimization. Sustainable green buildings are required to minimize global demand for non-renewable resources consumption and achieve sustainable development goals, enhance building resilience, in urban regions.

Keywords: Energy Efficiency; Environmental Impact; Green Building Techniques; Sustainable Construction; Sustainable Water Management

ICSBE24_107

SUSTAINABLE WATER MANAGEMENT IN GREEN ARCHITECTURE: A SYSTEMATIC REVIEW OF STRATEGIES, TECHNOLOGIES AND OUTCOMES

W.U.K. Perera[1*], H.A.T.N. Perera[2], G.Y. Jayasinghe[1]

[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Matara-Kamburupitiya Rd, 81100, Sri Lanka

[2]Department of Environmental Engineering, Faculty of Earth Science and Environmental Engineering,University of Miskolc, 3515,Miskolc, Hungary

**Correspondence E-mail: perera12gt@ags.ruh.ac.lk, TP: +94762697420*

Abstract: Worldwide water usage is increasing because of changes in demographics, increasing population, industrialization, and the impacts of climate. This review aims to (a) identify the possible strategies and technologies employed for water management in green architecture and (b) critical analysis to determine the environmental and economic Return On Investment (ROI) of practices (c) recommendations for future research study and the best practices to apply for green architecture. Using the PRISMA methodology to utilized on the paper's selections, the review study used 21 English-language articles out of 20,010 papers published between the years 2000 to 2024 using Google Scholar and ResearchGate; the filtering keywords are "sustainable construction", "green building techniques", "energy efficiency", "water management", and "environmental impact" with "AND", "OR" Boolean operators for expanded coverage. Prominent accomplishments include achieving a 90 % reduction in water usage through the application of optimal water fixtures and management practices, an 8 % reduction in the usage of water through conservations by the use of energy-efficient water fixtures; environmental sustainability practices at the site and the development of renewable technologies to boost the environmental sustainability of the site by 70 %. Green buildings address the issue of global greenhouse emissions with an 80 % reduction pushing for efficient strategies to check on climate change impacts. It also advances water efficiency as well as sustainability in green buildings; with a water efficiency rate of 37 % for certified buildings up to 6 % in water usage and cuts in energy usage by 40-50 %. As future recommendations, this review is directed at better management of water resources in green buildings, efficient metering and monitoring, and the use of technology on the cooling systems. Water-energy interface and triadic water-energy-waste link have a strong positive relation with the sustainable building environment.

Keywords: Energy Efficiency; Environmental Impact; Green Building Techniques; Sustainable Construction; Water Efficiency

ICSBE24_001

EFFECTIVE BIOMASS ADDITIVES FOR LOW-TEMPERATURE SLUDGE DRYING: A STUDY ON OPTIMAL RATIOS AND MATERIALS

W.A.D.H.P. Wijesooriya*, C.S. Kalpage
Faculty of Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: pgewe201927@eng.pdn.ac.lk, TP: +94767145450*

Abstract: Effective management of sewage sludge is crucial for its safe disposal or beneficial use. The water content of sludge impacts the efficiency and cost of treatment technologies, as it requires significant dewatering or drying to achieve desired moisture levels. Drying sewage sludge is challenging due to its high moisture content and complex physical and chemical properties. Incorporating biomass additives can provide economic and environmental benefits, but selecting the right additives involves careful consideration of several factors. However, using high additive ratios and elevated drying temperatures may still burden wastewater treatment plants. This study aims to conduct comparative analyses of different adjuvants (rice straw coco peat, sawdust, and rice husk) at lower addition ratios and to address existing research gaps by enhancing the performance of sewage sludge drying processes in low-temperature scenarios. The integration of agricultural biomass into mechanically dewatered sludge was implemented using varying proportions, ranging from 0 % to 20 % on a dry solid basis. This study utilized moisture ratio and characteristic analysis, as measured by a Fourier transform infrared spectrometer (FT-IR), for comparative evaluation. The study found that the rice straw blend has the significantly lowest abundance value for C-N (carbon-nitrogen) groups, leading to improved dewaterability and hence, improved drying characteristics. These findings collectively demonstrate that agricultural biomass can either enhance or diminish the associated functional groups, thereby increasing capabilities for water transfer. Consequently, this enhances the dewaterability of sludge and improves drying efficiency. In addition to that, the study found that, among the four types of agricultural biomass tested, rice straw with a 15 % adding ratio emerged as the optimal choice for enhancing drying efficiency at each addition ratio with the lowest drying time to become equilibrium moisture content.

Keywords: Waste Activated Sludge; Sludge Drying; Adjuvants; FT-IR

ICSBE24_021

AMOXICILLIN REMOVAL FROM WASTEWATER USING SRI LANKAN ACTIVATED CARBON

M.D.A.S. Manchanayake[1*], B.M.W.P.K. Amarasinghe[1], G.K. Jayatunga[2]
[1]*Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka*
[2]*Institiute of Technology, University of Moratuwa, Sri Lanka*
**Correspondence E-mail: ayeshamanchanayake@gmail.com, TP: +94713620602*

Abstract: Removal of pharmaceutical contaminants from wastewater has become a critical environmental concern. Adsorption of amoxicillin onto commercially available activated carbon in Sri Lanka is examined in this study. Batch experiments indicated that as the dosage of the adsorbent is increased the percentage removal of amoxicillin is increased. Furthermore, the study investigated the influence of pH on amoxicillin adsorption, revealing consistently high removal percentages (90 %) across a pH range of 2 to 10. However, a notable deviation occurred at pH 12, where the removal percentage decreased to 60 %. Adsorption Isotherm data were fitted to Langmuir and Freundlich isotherm models. The results showed a correlation coefficient for Langmuir isotherm model is 0.9724. Maximum adsorption capacity and Langmuir constant were calculated as 192.31 mg/g and 0.044 L/mg respectively. Freundlich model constants was determined to be 9.87 (mg/g) and Freundlich exponent that characterizes the adsorption intensity was 1.312. Kinetic analysis revealed adsorption experiment data best fit for pseudo second order model and rate constant for pseudo second order model increases as the activated carbon dosage increases, indicates that higher dosages of activated carbon enhance the adsorption kinetics of amoxicillin. Analysis of kinetic experimental data through the intra-particle diffusion model shows that the rate-limiting step of the adsorption of amoxicillin onto activated carbon is the intra-particle diffusion phase.

Keywords: Adsorption; Activated Carbon; Antibiotic; Amoxicillin

ICSBE24_009

ADVANCEMENTS IN SPIRAL PUMP TECHNOLOGY: FROM HISTORICAL ORIGINS TO MODERN INNOVATIONS

M. Dhanushi Rashmika*, Kasun Fernando, Ovin Lakpura Sriyarathna
Department of Applied Computing, Faculty of Computing and Technology University of Kelaniya
**Correspondence E-mail: rashmik-et19023@stu.kln.ac.lk, TP: +94715598845*

Abstract: Studying the history of the evolution of pump technology is crucial as it provides valuable insights into the progression of engineering solutions and the adaptation of materials and designs over time. Understanding historical advancements like the barsha pump, underscores its potential as a sustainable solution for water pumping challenges. That allows for the identification of enduring principles and innovations that have shaped modern pump technology. It has been around 300 years, utilizing modern and cost-effective materials through frugal engineering principles. The primary objective of this paper is to discuss important parameters from historical contexts that could aid in the develop various prototypes that could serve as viable alternatives for irrigation and potable water supply in challenging living conditions. Analyzing existing experiments, such as those conducted by the Windfarm Museum USA, helps us understand the forces at play within the pump mechanism. Ultimately, this research aims to deliver practical, efficient, and sustainable water access solutions for communities with limited resources.

Keyword: Spiral Pump; Blow-back; Wirtz Pump

ICSBE24_693

APPLICATION OF A VISUAL COLOR CHART FOR DISCHARGE WASTEWATER COLOR MONITORING IN THE TEXTILE INDUSTRY

K.M.S.T. Maduranga, S.H.I.S. Gunasiri, Pradeep Gajanayake*
Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Pitipana, Homagama, Sri Lanka
**Correspondence E-mail: pradeepgajanayake@sjp.ac.lk; TP: +94771522444*

Abstract: Textile wastewater is highly polluted effluent that puts a high strain on the global water environment and often faces challenges related to wastewater treatment, particularly in achieving consistent color removal from discharge effluent. Traditional methods of monitoring color change, such as the Pt/Co measurement and absorbance techniques, rely on periodic laboratory analyses, which can lead to inefficiencies and chemical wastage due to the delay between monitoring and chemical application. To address this problem, a color chart is developed to enable, on-site monitoring of wastewater color and optimize chemical dosing for decolorization. A reference color chart is created using standard procedures, including a dilution series and photographic documentation with a 12.2 MP camera under controlled conditions. The reference color chart values are compared with Pt/Co measurements and absorbance values at three wavelengths (yellow, red, and blue). At last the daily color variation of discharge wastewater is measured by developing a standardized color chart. The results of the study revealed a strong correlation, yellow absorbance with p-value = 0.000, and R^2 = 95.7 %, supporting the effectiveness of the visual color chart for wastewater monitoring. A weak positive relationship is indicated by a p-value of 0.046, between the reference color chart values and the Pt/Co (Hazen) values. Further analysis exhibits that yellow absorbance, before applying the color chart to the treatment plant is not significantly lower than the tolerance limit, although after implementing the color chart, average absorbance is significantly below the tolerance limit. The study demonstrated that the reference color chart is a practical and cost-effective tool for assessing color changes, improving the efficiency of the decolorization process by reducing chemical usage for textile wastewater discharge. Further research could focus on developing a mobile application to streamline color monitoring and provide real-time data for improved management of wastewater treatment processes.

Keywords: Reference Color Chart; Decolorization; Textile Industry; Wastewater Color Measurement

ICSBE24_169

ANALYSIS OF THE PATHOGENS TRANSPORT FROM ON-SITE WASTEWATER TREATMENT SYSTEM IN DIFFERENT TYPE OF SOIL

T.H.F. Aagani[1*], G.G.T. Chaminda[1]
[1]Department of Civil and Environmental Engineering, Faculty of Graduate studies, University of Ruhuna, Galle
**Correspondence E-mail: aaganiharried@gmail.com, TP: +94771145942*

Abstract: The aim of this research paper is to evaluate the degree of the transportation of E-choli bacteria through different types of soil namely gravel soil, sandy soil and clayey soil. In Sri Lanka, common practice of on- site wastewater disposal system is soakage pit. Therefor the transport of pathogenic organisms from soakage pit to the environment through different type of soil is studied in this research. Furthermore, this study also concentrated the behaviour of the other wastewater contaminants such as BOD5, Solids concentration and the turbidity. The soil column was designed by using different type of soil. Waste water from the effluent of a wastewater treatment plant was poured into the soil column and tests were carried out at influent and effluent of the soil column. The soil column was prepared with the different type of soil around soakage pits. The influent wastewater was not contaminated with E-choli bacteria. However, the presence of E-choli bacteria in the effluent confirms the presence of E-choli bacteria in the soil column which was prepared with the soil around soakage pits. However, the amount of E-choli found in the effluent sample varies with the type of soil. (i.e. E-choli in clayey soil < E-choli in sandy soil < E-choli in gravel soil). Furthermore, the BOD5 was found to be less in effluent than in the influent. However, the total solids concentration and the turbidity was more in the effluent than the influent. The result of the study shows that the pathogens get transported from soakage pits to the environment and degree of movement of the waste contaminants vary with the type of the soil around the soakage pit.

Keywords: E-Choli; BOD_5; Solids Concentration; Turbidity; Pathogens; Soakage Pit; Wastewater Treatment System; Soil Type

ICSBE24_921

ASSESSING SHELF LIFE OF ELECTROLYZED ALKALINE WATER IN DIFFERENT STORAGE CONTAINERS AND CONDITIONS

C.A.H.M.D.A. Chandrasekara[1], S.Sajitthan[2*], O.G.C.K.H.B. Udawatta[3], P.P.G.I.P. Bandara[4], I.M.W.K. Illangasinghe[5], E.P. Rajapakse[6]

[1,4] University of Peradeniya
[3] South Eastern Universityof Sri Lanka
[2,5,6]National Water Supply and Drainage Board
**Correspondence E-mail: sajitthan95@gmail.com, TP: +94777497095*

Abstract: Alkaline water, with its antioxidant effect, is believed to cure diseases caused by free radicals. Based on the literature the alkaline water generated through direct current electrolysis has a pH range from 8.50 to 9.80 and a negative oxidation-reduction potential (ORP) value between -140.0 to -400.0 mV. However, the possibility of retaining these parameters in alkaline water is yet to be verified. The objective of this research is to investigate the change of characteristics in electrolyzed alkaline water (EAW) while storing in different types of containers at room temperature (25°C) and in the refrigerator (4-5°C) to ensure its longevity. The production of EAW was carried out using Kobbawala Borehole-pipe borne water (located in Gampola,Sri Lanka), using the ZR20-20-001 acid/alkali electrolyzer and AC/DC power converter, offering a power supply range of 0-10 A and 0-30 V. The produced EAW is stored in plastic, glass, stainless steel (SS), and clay bottles at room temperature and in the refrigerator. Over a predetermined period, the pH, negative ORP, hardness, alkalinity, and conductivity of the EAW were tested at regular intervals. Right after the production, EAW exhibits an ORP range of -425mV and -773mV and a pH range of 7.6 to 8.9. The findings after 10 days of storage show that the decreasing rate of negative ORP, and pH of EAW are dependent on the storage temperature and the different container types. At room temperature, EAW parameters could be maintained for 1, 2, 5, and 0 days in plastic, glass, SS, and clay bottles, respectively. EAW parameters in plastic, glass and SS bottles stored in a refrigerator can be maintained for up to 5,17 and 17 days respectively. The residue propagation of calcium carbonate and magnesium hydroxide was observed while storing at room temperature, and its effect on electrolyzed alkaline water was also investigated. The water quality parameters, such as hardness, alkalinity, and conductivity of the EAW samples, except for pH, are within the limits of SLS 614:2013.

Keywords: Alkaline Water; Electrolysis; ORP; pH; Shelf Life

ICSBE24_073

GRAPH NEURAL NETWORK-BASED SURROGATE MODEL FOR DESIGN-INFORMED STRUCTURAL OPTIMIZATION

Nisal Ariyasinghe[1], Hansani Weeratunga [2], Chinthaka Mallikarachchi[1], Sumudu Herath[1*]

[1]Department of Civil Engineering, University of Moratuwa, Bandaranayaka Mawatha, Moratuwa 10400, Sri Lanka
[2]Sri Lanka Institute of Information Technology Malabe Campus, New Kandy Road, Malabe 10115, Sri Lanka
**Correspondence E-mail: sumuduh@uom.lk, TP: +94719882168*

Abstract: Structural optimization of skeletal forms is crucial in weight-sensitive applications. Optimizing such structures often involves iterative, computationally intensive methods, which are inefficient under varying design parameters and constraints. his paper introduces a novel surrogate model based on Graph Neural Network (GNN) for real-time structural optimization, aimed at significantly reducing computational costs In our approach, trusses composed of pin joints and connecting members are represented as graphs, where joints correspond to vertices and members to edges. This correspondence forms the use of Graph Neural Networks (GNNs) to predict topology and size-optimized truss structures. The GNN models the truss as a graph, with edges denoting member cross-sectional areas and nodes representing truss joints, based on input parameters such as geometry, load combinations, and boundary conditions. The resulting predicted structure reflects the optimized topology and member sizes. The proposed model bypasses the need for iterative computations by learning from a dataset comprising various problem definitions and their corresponding optimized results. This GNN-based optimization holds substantial promise for design scenarios requiring rapid and reliable optimization, demonstrating the potential for significant computational time savings while maintaining high accuracy in predicting near-optimal truss layouts. This is particularly significant in the context of sustainability, where industrial users can produce optimally designed structures with minimal material usage within a fraction of the computational power and time required for different applications. Testing results indicate that the model effectively generalizes across various design scenarios, providing near-optimal solutions with minimal computational effort. Specifically, the predicted structures exhibited a normalized root mean square error (NRMSE) of less than 10^{-3} and R^2 values approaching unity. Additionally, predictions were made in under 0.01 seconds, demonstrating both accuracy and efficiency.

Keywords: Structural Optimization; Truss Structures; Graph Neural Networks; Sustainable Designs; Surrogate Models

ICSBE24_181

EXPLORING THE POTENTIAL OF COLOURED GLASS PARTICLES AS FINE AGGREGATE REPLACEMENTS IN CONCRETE: AN EXPERIMENTAL STUDY

D.H.A. Maduranga[1], J.M.R.S. Appuhamy[1], W.M.K.R.T.W. Bandara[1], C.E. Kankanamge[1]

[1]Department of Civil and Environmental Engineering, Faculty of Engineering, University of Ruhuna, Galle.

**Correspondence E-mail: dhamaduranga@gmail.com, TP: +94718537269*

Abstract: Glass waste is a one of the substantial materials that can be used in concrete mixes to enhance global sustainable development by reducing the environmental effect of concrete manufacturing and lowering global waste production. However, it is essential to maintain the quality of concrete while integrating glass waste. This research aims to examine the impact of various colored glass particles on concrete mixes, focusing on mechanical, dynamic, and durability characteristics. Clear, green, and brown glass particles were used as partial substitutes for fine aggregates, with volumetric replacement percentages varying from 2.5% to 15%. In all replacement ratios, glass-mixed concrete demonstrated enhanced compressive strength, exceeding the characteristic strength of grade 30. The increase in strength is mostly related to the pozzolanic behavior of the glass particles. A 10% replacement ratio produced the highest compressive strength across all three glass colours. The workability of the concrete mixes increased with an increase in glass content, although there was no notable effect on the dynamic properties of the concrete. The Alkali Silica Reaction (ASR) results shown that the colour of glass influences ASR growth. Clear glass concrete had highest ASR growth, while green glass showed the least, and brown glass had a moderate impact. Therefore, the colour of the glass did not impact the mechanical or dynamic properties of the concrete mixes, although it did affect ASR expansion. According to these results, green glass is recommended as the most promising material for maintaining both the mechanical performance and long-term durability of concrete applications.

Keywords: Mechanical Properties; Pozolanic Behaviour; Alklai-Slica Reaction (ASR); C-S-H bonding; FT-IR Analysis

ICSBE24_174

SHEAR STRENGTH OF PLAIN CONCRETE WITH RECYCLED POLYPROPYLENE PLASTIC AGGREGATES

K.G.D.I.H. Thilakarathna*, T. Abirami, W.A.R.U. Weragama, C.S. Bandara
[1]*Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, 20400, Sri Lanka*
**Correspondence E-mail: hashanthilakarathna24@gmail.com, TP: +94715174147*

Abstract: This study aimed at the potentialities of replacing natural coarse aggregate (NCA) with recycled polypropylene (PP) plastic waste for normal-strength concrete. It mainly focused on comparing the analytical shear strength of plain concrete incorporated with recycled PP waste with the experimental results obtained by the push-off tests. The experimental work included a varying percentage of polypropylene plastic aggregate (PPA) as 10%, 20%, and 30% volumetric replacement of NCA for the water/cement (w/c) ratio of 0.55. The initial experimental results concluded that the workability decreased with the increasing PP% and a super-plasticizer was required to achieve adequate workability. The compressive strength was reduced by 14%, 19% and 31% respectively for the 10%, 20% and 30% of PP content. Similarly, PAC was weaker in shear than natural aggregate concrete (NAC) and push-off shear strength (ν_{po}) was reduced by 9%, 12% and 18% for increasing PP content. The determination of the shear strength of plain concrete by using the provisions available in BS EN 1992-1-1-2004 was more conservative for plastic aggregate concrete (PAC) and a new empirical equation was proposed to obtain the push-off shear strength (ν_{po}) in terms of the cube compressive strength (f_{cu}). However, this relationship was satisfied for both PAC and NAC and the relationship was $\nu_{po} = 0.61 \sqrt{f_{cu}}$.

Keywords: Polypropylene (PP); Coarse Aggregate; Shear Strength; Plain Concrete; Push-off Test

ICSBE24_054

MECHANICAL RESPONSES OF CONCRETE WITH SURFACE-TREATED CALICUT TILE AGGREGATES

S. Kishotharan[1], H.M.C.C. Somarathna[1,2*], J. Johnkeshanth[1], M.M.M. Kaashif[1]
[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka.
[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka.
**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: The best mechanical properties are necessary for concrete which is a fundamental material in construction. However, the widespread use of natural aggregates in the manufacturing of concrete greatly contributes to resource depletion and elevated carbon emissions, which worsen environmental conditions. Recycling techniques provide sustainable ways to reduce these effects by utilizing recycled materials like broken Calicut tiles in the creation of concrete. The objective of this study is to investigate the efficacy of cement mortar coating as a means of improving the mechanical characteristics of Calicut tile aggregates (CTA), used in concrete in place of natural coarse aggregates (NCA). The study focuses into adding both treated and untreated CTA in concrete mixtures with 0%, 20%, 40% and 60% replacement ratios in order to achieve a maximum compressive strength of 25 MPa. The mechanical properties evaluated include compressive strength, strain, maximum stress and strain energy at ages 7, 14 and 28 days. Experimental results demonstrate that treated CTA significantly enhances the mechanical performance of concrete. Specimens with 60% treated CTA achieve impressive compressive strengths up to 30 MPa at 28 days, surpassing those with untreated CTA and approaching the performance of specimens with 100% NCA. Maximum stress values consistently show higher performance in specimens with treated CTA across all replacement ratios and ages tested, underscoring the efficacy of the coating method in enhancing load-bearing capacity. Strain and strain energy analyses reveal initial variations with replacement ratios, converging to similar values by 28 days, indicating the durability and stability of concrete incorporating treated CTA over time. The potential of cement mortar coating as a sustainable strategy to improve the mechanical properties of recycled aggregates like CTA, thereby reducing reliance on natural resources and promoting the circular economy in construction practices.

Keywords: Calicut Tile Aggregates; Recycling Techniques; Cement Sand Coating; Concrete

ICSBE24_098

THE SUSTAINABILITY IMPACTS OF MATERIAL REUSE IN RESIDENTIAL CONSTRUCTION PROJECTS

H.A.D.M. Happitiya*, K.P.K.M.H. Polhena, M.G.P. Manelgama, J. Wijesundara
School of Architecture, Sri Lanka Institute of Information Technology
**Correspondence E-mail:dinalihappitiya@gmail.com, TP: +94762767180*

Abstract: Due to the rapid increase of environmental issues sustainability in building construction is more crucial than ever. Under environmental sustainability, material reuse plays a pivotal role since material waste has become a huge problem in construction sites. On the other hand, ensuring the quality of the space and structural integrity can be a significant challenge when re-using materials and elements for new construction. This paper explores and compares the sustainability implications of three different residential projects that use techniques for reusing building materials and elements in response to growing environmental concerns. This study intends to identify the public perception of material reuse, project-specific strategies, challenges, and opportunities for the reuse of building materials or elements. Further, it aims to evaluate the cost difference of reuse of materials with original materials and study the spatial quality and environmental comfort of each project from the user and the designer's perspective. This research employs a method including case studies, exploratory interviews with deep onsite observations, and questionnaires. Through the study, public perception of the reuse of materials for new constructions, insights into cost savings, spatial quality, and environmental comfort, and the contribution of reused materials to sustainability could be obtained. The study concludes that material reuse plays a vital role in promoting environmental sustainability in the building industry. Case studies have yielded important insights that show how cost reductions and increased environmental comfort can be achieved without sacrificing spatial quality. The study outcome emphasized how crucial it is to keep innovating and working together to maximize the sustainability impact of material reuse techniques.

Keywords: Construction Material Reuse; Public Perception; Cost Comparison; Spatial Quality; Environmental Comfort; Sustainability

ICSBE24_452

ASSESSING THE ADOPTABILITY OF MATERIAL REUSE IN SRI LANKAN BUILDING CONSTRUCTION PROJECTS: A CIRCULAR ECONOMY PERSPECTIVE

K.G.D.K. Harinya*, D.M.S. Jayasuriya
General Sir John Kotelawala Defence University
**Correspondence E-mail: kethmiharinya65@gmail.com, TP: +94767525853*

Abstract: Global resource usage and waste production are both significantly influenced by the construction industry. As currently the Sri Lankan construction industry is working towards sustainable development, circular economy could be a salutary concept to minimize negative environmental effects and improve resource efficiency. The circular economy concept is incorporated with three main principals of Reduce, Recycle and Reuse, which now has been evolved into ten principals. With an emphasis on circular economy concepts, this study attempts to examine the possibilities for construction material reuse in the building constructions in local context. The main goal of this study is identifying challenges and benefits of following reuse principal in construction material in local building context. Research methodology describes the methodical procedure which was used to gather, analyses, and interpret data in order to meet the goals of the study. The research strategy is a qualitative approach. The initial stage of the research methodology consisted of a thorough literature review which will followed on identifying main challenges to follow material reusing in building construction. Semi-structured interviews, will follow up with further gathering data aimed at exploring and understanding effective ways of construction material reuse principal in the local building construction context. This study will provide with a significant overview of the adoptability of following reusing construction material in building construction projects in Sri Lanka context.

Keywords: Circular Economy; Construction Material Reuse; Sustainable Construction; Building Construction; Sri Lankan Construction Industry

ICSBE24_097

RECYCLING SOLUTIONS FROM END-OF-LIFE TEXTILE WASTE IN SRI LANKA FOR BUILDING AND DECORATIVE MATERIALS

K.K. Dias[1], T.D. Amarasooriya[2*]
[1]School of Civil and Mechanical Engineering, Curtin University, Perth, WA 6845, Australia
[2]Sri Lanka Institute of Information Technology, New Kandy Road, Malabe, Sri Lanka
**Correspondence E-mail: thilini.d@sliit.lk, TP: +94771885252*

Abstract: The textile industry is a notable industry in Sri Lankan exports, it generates a large amount of textile waste each year which causes a serious problem for the environment creating more landfill due to customer behaviour and economic status of consumers. This research was conducted to quantify the reduction of carbon footprint of end-of-life textile waste from the industry with the understanding of recycling textile waste with efficient waste management techniques and clothing recycling technologies. Textile waste recycling reduces the need for landfill space, and the pressure on virgin materials, also encourages the development of additional markets. Unavailability of a secondary market in Sri Lanka for textile waste, special equipment, talent and facility create multiple challenges in recycling textile waste in the country. Currently, in Sri Lanka, textile companies usually only reuse textile off-cuts greater than a length of 6 inches. The rest are either given to textile waste collectors or dumped into Board of Investment (BOI) - Sri Lanka dump yards, where the waste is collected by a private cement company to be used as an energy source by incinerating. Through literature review it was found that, using the mechanical textile waste recycling technique can produce bricks (construction material) and floor carpets (decorative/interior consumable). Our carbon footprint calculations found that a brick of 7.5″×4″×2″ dimension out of 2.5 kg (dry) of textile waste and a floor carpet of 10 m×10 m dimension out of 40 kg (dry) of textile waste would reduce carbon footprint of end-of-life textile waste to 17,588 kgCO_2e from 35,169 kgCO_2e in 2023. A collection of eight other manufacturers including the key manufacturer in the same export processing zone in early 2024 reduced the carbon footprint from 88,770 kgCO_2e to 43,470 kgCO_2e which ultimately helped to reduce the total carbon footprint by close 50 % and reduced 41,313 kg of total materials released to landfill.

Keywords: Circular Economy; Environment; Niche Markets; Sustainable

ICSBE24_019

EXPERIMENTAL INVESTIGATION ON A SURFACE TREATMENT TECHNIQUE TO ENHANCE THE PERFORMANCE OF CALICUT TILE AGGREGATES

S. Kishotharan[1], H.M.C.C. Somarathna[1,2*], M.M.M. Kaashif[1], J. Johnkeshanth[1]
[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka
[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: The acceleration of urban development has noticeably escalated construction activities and the requisition for concrete, which predominantly depends on natural aggregates. In light of the finite access to these natural resources, investigative alternate materials that preserve the mechanical robustness of concrete is imperative. Scholarly investigations reveal that the incorporation of Calicut Tile Aggregates (CTA) as a renewable substitute for Natural Coarse Aggregates (NCA) in concrete compositions up to 40% of NCA is feasible with negligible detriment to performance. The objective of the present study is to enhance the properties of CTA through a surface treatment technique, specifically a cement sand coating, to amplify its compatibility and adhesion with the cement matrix. The methodology encompasses immersing the fragmented CTA in water for 24 hours, followed by the application of a coating of a mix of one part cement to two parts sand, and subsequently curing the coated aggregates for 28 days. The proposed treatment has been shown to enhance the physical and mechanical properties of CTA, endorsing its application as a sustainable construction aggregate. Experimental outcomes indicate that the processed CTA exhibits an enhanced specific gravity, diminished water absorption rate, and enhanced mechanical performance. Comparative analyses were conducted on concrete specimens utilizing various compositions: entirely NCA, untreated CTA and treated CTA, with partial substitutions at increments of 20% and 40%. These examinations disclosed that treated CTA showcased an improvement in compressive strength and energy absorption capacity. Consequently, the application of treated CTA addressed the intrinsic limitations of untreated CTA, potentially enhancing the ductility and resilience of the resultant composite material.

Keywords: Calicut Tile Aggregates; Surface Treatment; Recycled Aggregates; Sustainable Concrete

ICSBE24_240

ASSESSING THE ROLE OF MANGROVES IN REDUCING BLUE CARBON FOOTPRINT: IMPORTANCE, THREATS, AND CONSERVATION STRATEGIES FOR CLIMATE CHANGE MITIGATION

N. Saheedha*, C.P. Rupasinghe
[1]*Department of Agricultural Engineering & Environmental Technology, Faculty of Agriculture, University of Ruhuna, Matara, Sri Lanka*
**Correspondence E-mail: saheedha7gt@ags.ruh.ac.lk, TP: +94770461127*

Abstract: Mangroves, salt marshes, sea grass meadows, and tidal freshwater wooded wetlands are considered "blue carbon" environments due to their high carbon sequestration and storage densities. However, their loss contributes disproportionately to carbon emissions due to their high carbon efficiency, making them a "blue carbon" environment. The worth of mangroves in storing carbon, their capacity to do so, and their contribution to reducing climate change are all highlighted in this review. Mangroves are ideal for producing carbon credits due to their capacity as carbon sinks, natural disaster resistance, and ecosystem services like fish-spawning grounds and coastal protection. They absorb carbon dioxide through photosynthesis, creating organic matter that they store in their biomass and sediments. This ability to absorb blue carbon is crucial for mitigating the effects of climate change. Mangroves can sequester carbon for hundreds to thousands of years, making them a resilient tool for reducing atmospheric carbon dioxide concentrations. The low oxygen content of wet soils also slows down decomposition, allowing blue carbon to remain in situ for extended periods. The threats posed by deforestation, land conversion, and climate change to mangrove ecosystems Prawns. The assessment also addresses the industries of farming, tourism, agriculture, coastal development, coal, and lumber that endanger their ability to store carbon dioxide. To improve mangroves' function in carbon management, effective conservation and restoration are essential. The study suggests that mangrove restoration could significantly reduce global carbon emissions if included in carbon credit programs and climate policies. It emphasizes the importance of protecting mangrove ecosystems as a natural response to climate change and promotes global cooperation and sustainable management practices. The review aims to raise public awareness and advocate for policies supporting mangrove conservation and restoration.

Keywords: Biomass; Blue Carbon; Carbon Sequestration; Fish-spawning; Photosynthesis.

ICSBE24_081

CARBON FOOTPRINT ANALYSIS AND MITIGATION STRATEGIES FOR CONSTRUCTION PROCESSES IN SMALL-SCALE HOUSING PROJECTS: A CASE STUDY IN KANDY DISTRICT, SRI LANKA

K.A.S.H. Wijayasenarathne[1*], P.I.M. Ariyawansha[2], R.M.A. Dilini[1]
[1]Department of Environmental Technology,
Sri Lanka Technology Campus, Padukka, Sri Lanka
[2]Salasi Lanka Pvt (Ltd), 44, Salasi Tower,Temple Road, Maradana, Sri Lanka
**Correspondence E-mail: harshaniwi@sltc.ac.lk, TP: +94716674566*

Abstract: The construction industry in Sri Lanka significantly impacts environmental sustainability, using over 50 % of raw materials and approximately 35 % of national energy consumption, thereby playing a considerable role in global greenhouse gas (GHG) emissions. Most current research on GHG emissions in Sri Lanka's construction sector focuses on embodied carbon emissions, with limited studies into emissions from construction activities. Although these activities contribute less to the overall lifecycle emissions of buildings, estimating their carbon footprint presents opportunities for contractors to reduce emissions substantively. This study aims to assess the GHG emissions associated with the construction process of a small-scale housing project with 16 housing units in the Kandy district of Sri Lanka and the embodied emissions of the main building materials. The assessment covers emissions categorized under Scope 1 (direct emissions like onsite diesel combustion), Scope 2 (indirect emissions from grid electricity consumption), and Scope 3 (other indirect emissions such as material transportation, subcontractor transportation, and waste management) in accordance with Greenhouse Gas Protocol (GHG Protocol) and ISO140064 guidelines. The study estimated the total GHG emissions for the project at 1,404.55 tCO2-eq. The major emissions sources were grid electricity usage (55.77 %) and raw material transportation (39.14 %). Clay bricks emerged as the most significant contributor within the material transportation category, accounting for 29.72 % of total emissions. The total embodied carbon emission was estimated at 677,511.44 tCO2-eq, with clay bricks as the major contributor (99.03 %). To mitigate these emissions, the study recommends several strategies: integrating renewable energy sources into construction activities, optimizing raw material transportation with mass transit options, favoring local sourcing of materials, ensuring efficient vehicle operations and maintenance, utilizing recycled materials from demolition waste, reusing onsite materials like rubble and soil, and implementing rainwater harvesting systems to collect rainwater during the rainy season.

Keywords: Carbon Footprint; Climate Change; Construction; GHG Emission; Sustainability

ICSBE24_168

CALCINATION AND MECHANICAL ACTIVATION OF WASTE CLAYS FOR LOW-CARBON CONCRETE

Roshan Jayathiakage*, Chamila Gunasekara, David Law, Sujeeva Setunge
Civil & Infrastructure Engineering, School of Engineering, RMIT University, Melbourne, Victoria 3000, Australia
**Correspondence E-mail: roshan.jayathilakage@rmit.edu.au, TP: +61420919206*

Abstract: To address the issue of high CO_2 emissions from global cement production, the use of waste materials, like waste clays, is becoming increasingly popular. This study focuses on natural mixed-layer waste clays from Australia as Supplementary Cementations Materials (SCMs) in concrete, exploring the challenges posed by varying mineral compositions and activation methods. Three types of waste clays with different mineralogical compositions and sources were examined, with activation techniques including calcination and mechanical grinding, adjustment of temperature (for calcination), and duration (for mechanical activation) of activation. The results pinpoint the best conditions for improving clay reactivity. It was also discovered that calcined clays with more than 20 % total clay mineral content and a particle fineness exceeding 85 % exhibited superior mechanical performance compared to control mixes that did not include clays.

Keywords: Calcined Clay; Cement; Activation; Clays; Low-carbon; Kaolinite

ICSBE24_172

DIGITAL BUILDING PASSPORT FOR RESIDENTIAL DWELLINGS

L.Thilakarathna[1*], N. Weerasinghe[1], R. Edirisinghe[2], S. Setunge[1]
[1]School of Engineering, RMIT University, Melbourne, Australia
[2]School of Property Construction and Project Management, RMIT University, Melbourne, Australia
**Correspondence E-mail: s3962334@student.rmit.edu.au, TP: +61447348875*

Abstract: The growing demand for residential buildings has significantly increased the consumption of resources, contributing to approximately 24 % of overall electricity use and over 10 % of total carbon emissions in Australia. In the context of climate change, addressing the Circular Economy (CE) principles such as minimising waste, optimizing resources, reducing carbon emissions, and improving the energy performance of the buildings has become increasingly critical concerns. "Digital building passport" is one such emerging tool designed to capture all the dynamic information throughout its lifecycle and enable the monitoring of circularity and sustainable building performance. However, the development of comprehensive building passports is still in its early stages, with the absence of a fully integrated material passport encompassing the entire life cycle limiting its practical application. This study aims to develop a digital building passport for a residential building. A comprehensive literature review has been carried out and a Case study: A two-story residential building has been employed to demonstrate the conceptualized digital building passport. The research findings provide passport attributes, data sourcing methods, and relevant BIM attributes across the stages of production, construction, use, end-of-life, and supplementary benefits. This study contributes to all stakeholders' decisions on the sustainability and circularity of residential buildings.

Keywords: Building Passport; BIM; Circular Economy; Sustainability; Case Study

ICSBE24_059

ESTIMATION OF CARBON SEQUESTRATION IN THE LOLC FINANCE DENIYAYA REFORESTATION AND BIODIVERSITY RESTORATION PROJECT

S.D.S.A. Wijerathna*, E. Lokupitiya
Department of Zoology and Environment Sciences, Faculty of Science, University of Colombo, 94, Kumaratunga Munidasa Mawatha, Colombo 03, Sri Lanka
**Correspondence E-mail: sithuminiwi@lolcfinance.com, TP: +94778570826*

Abstract: This study quantifies the carbon sequestration potential of a 20,000-tree reforestation project implemented by Team Thuru within the Ensalwatte Estate in Deniyaya, Sri Lanka. The project site, leased by LOLC Finance PLC from Mathurata Plantation, is situated near the Sinharaja Rain Forest, a UNESCO World Heritage site. The methodology focused on quantifying the increase in ground biomass over a 20-year period, specifically addressing the aboveground and belowground woody biomass. Field measurements of tree height and girth were conducted for a subset of 1,253 trees, ranging in age from one week to one year. Growth models from existing literature and field data were employed to estimate Diameter at Breast Height (DBH) and calculate aboveground biomass using allometric equations. Belowground biomass was estimated based on a root-to-shoot ratio. Results indicate significant carbon sequestration potential within the project area. At year 1, the project is projected to sequester 445.06 tons of CO2, decreasing to 344.76 tons at year 5, 207.97 tons at year 10, and reaching a substantial 5,852.75 tons at year 20. This corresponds to total biomass amounts of 242,740.5 kg, 118,031.4 kg, 113,428.6 kg, and 3,192,118 kg respectively over the same period. These findings highlight the cumulative impact of the project on carbon sequestration over time. This research provides valuable insights into the carbon sequestration capacity of reforestation efforts in the region and contributes to the broader understanding of climate change mitigation strategies. The findings underscore the importance of utilizing native species and adopting suitable methodologies to maximize ecological benefits. Continued monitoring of tree growth and the development of species-specific growth models will further enhance the accuracy of future carbon sequestration estimates for this project and inform similar initiatives.

Keywords: Aboveground; Belowground; Total Carbon; Carbon Sequestration; Reforestation

ICSBE24_192

ORGANIZATION CARBON FOOTPRINT CALCULATION FOR NON-BANK IN SRI LANKA – A CASE STUDY FOR LOLC FINANCE PLC

N.S. Liyanage[1], Y.R. Kodagoda[1], Pradeep Gajanayake[1*], S.D.S.A. Wijerathne[2]
[1]Department of Biosystems Technolgy, Faculty of Technology,
University of Sri Jayewardenepura, Pitpana, Homagama, Sri Lanka
[2]LOLC Finance PLC, No 100/1 Sri Jayewardenepura Mawatha, Rajagiriya, Sri Lanka
**Correspondence E-mail: pradeepgajanayake@sjp.ac.lk, TP: +94771522444*

Abstract: One of the most important steps for companies to reduce greenhouse gas (GHG) emissions is accurately calculating their carbon footprint. This study focuses on estimating and analyzing the carbon footprint of LOLC Finance PLC. It is the largest Non-banking finance company in Sri Lanka. The analysis follows the ISO 14064 standards, with GHG inventories being planned and organizational and operational boundaries set under three different Scopes. Emissions are divided into three categories: Scope 1 covers direct emissions from the company's processes, Scope 2 includes emissions from energy use and Scope 3 accounts for other indirect emissions from the value chain. This study identified the main sources of carbon emissions in the LOLC Finance PLC company's operations. Scope 1 includes company direct paid emission sources, Scope 2 includes emissions from energy use and Scope 3 accounts for other indirect emissions from the value chain. The findings reveal a total carbon footprint of 7297.6 tCO2e with an average emission rate of 1.4 tCO2e per employee emission. Indirect emissions (7170.39 tCO2e) overwhelmingly surpass direct emissions (127.21tCO2e). The significant rise in indirect emissions, particularly from grid electricity and employee commuting, underscores the need for target intervention. By accurately measuring and calculating its carbon footprint, LOLC Finance PLC is positioned to take responsibility for its environmental impact. As a result of this analysis, the company is now poised to take active steps to minimize its footprint and integrate sustainable practices across all levels of its operations. The LOLC Finance company now sets measurable goals to reduce its greenhouse gas emissions. The study recommends improving energy efficiency while enhancing the financial sector's understanding of carbon management to support Sri Lanka's sustainability goals and environmental responsibility.

Keywords: Carbon Footprint; GHG Emissions; Energy Efficiency; Scope 1,2,3 Emission; Sri Lanka

ICSBE24_007

DEVELOPMENT OF AN ODORLESS RAPID COMPOSTING MACHINE FOR DOMESTIC USE

A.A. Darshani, K.K.D.V.N. Kannangara, S.A. Kariyawasam, J.G.A.S. Jayasekara*
Department of Mechanical Engineering, University of Moratuwa, Katubedda, Sri Lanka
**Correspondence E-mail: saliya@uom.lk, TP: +94763221274*

Abstract: The escalating waste problem, driven by rapid population growth around the world, poses significant challenges in organic decomposition and waste management. In Sri Lanka, inadequate waste management practices exacerbate these issues, leading to environmental degradation and health concerns. This study focused on design and development of low odor, energy efficient composting machine for residential use. The machine employs a mechanical composting method that involves heating, drying, and mixing organic wastes to develop a conducive environment for microbial activity. The experimental results have shown that the optimal temperature for composting is in a range between 55-65 °C, a food waste load of 7 kg, and the use of Material in Process (MP) as an effective additive. The test bed turned garbage into compost within 72 hours under these conditions. Odor control was successfully achieved through the activated carbon filtration system, significantly reducing unpleasant smells. This project results are promising a practical solution for managing household organic waste, promoting sustainable waste management practices and environmental preservation. Future work will focus on further optimizing the machine's design and operational parameters to enhance its performance and cost effectiveness.

Keywords: Composting Machine; Waste Management; Odor Control; Organic Waste; Residential Composting; Activated Carbon

ICSBE24_162

SUSTAINABLE HOUSING SOLUTIONS FOR DISPLACED SRI LANKANS

Kavitha Vipulananda*
The University of Melbourne, Infrastructure Engineering, Victoria 3010, Australia
**Correspondence E-mail: vipulanandak@student.unimelb.edu.au, TP: +61402038855*

Abstract: A social issue is a situation that negatively affects the personal or social lives of individuals or the well-being of communities or larger groups within a society. Some of these social issues could include refugees fleeing from war, earthquakes and flood. Sri Lankan communities over time have had a significant impact from floods and associated landslides. When a social issue causes a particularly vulnerable population to be impacted, through losing home, shelter, abode and general amenities, they become displaced. "Displaced" implies that due to some of the social issues faced, floods and landslides, they become "displaced" and often homeless and require urgent housing. Often rapid, cost-effective housing is required for this dire situation. Rapid, emergency and affordable is always required and it is recommended that some sort of construction automation is applied, to build fast and more cost effectively. These options include Prefabrication, Automation, Robotics, and other Innovative use of AI technology. Although these various construction methodologies exist, I am yet to find a methodology that specifically addresses certain post disaster (whether natural or otherwise) situations, where population become displaced and yet also consider sustainable and low carbon footprint options. Through the investigations of the various methodologies of construction in these disastrous situations, it seems that due to the loss of infrastructure and roads, it can be in some cases, impossible to construct onsite. This means that prefabrication of some form, would be the most viable. Thereafter installation can be done onsite. The other benefit of prefabrication is the reduction in carbon footprint and the various sustainable and green building impacts. Various options of prefabrication and benefits were investigated, and this analysis discusses these in further detail.

Keywords: Building Automation; Carbon Footprint; Construction Management; Innovations in Building Materials; Sustainable Construction and Green Building Techniques

ICSBE24_440

MODELLING SEISMIC RESILIENCE FOR MULTI-HAZARDS AND CASCADE DAM FAILURES: CASE STUDY FROM SRI LANKA AND AUSTRALIA

Srikanth Venkatesan*
STEM College, Royal Melbourne Institute of Technology (RMIT), Melbourne, VIC 3001, Australia
**Correspondence E-mail: srikanth.venkatesan@rmit.edu.au, TP: +61401620770*

Abstract: Dam Breaches are causing severe hazards in the downstream areas by generating destructive flash floods. This study analyses the impact of downstream floods due to piping failures of embankment dams. The Tabbowa reservoir in Sri Lanka was taken as a case study. Breach sections and parameters were estimated using four breaching mechanisms based on empirical equations: MacDonald and Langridge – Monopolis method, Froehlich method, Von Thun & Gillette method, and Xu & Zhang nethod. US Army Corps HEC-RAS was utilised to develop the hydrodynamic model which, assessed downstream flood characteristics under varying reservoir water levels for each breach mechanism. The results reveal a clear relationship between reservoir water levels at breach initiation and downstream flood severity. Higher reservoir levels lead to increased flood wave heights, more extensive inundation, and faster flood wave propagation. MacDonald and Langridge – Monopolis method show the highest variation of the breach flows against the reservoir water level at breach initiation among the four dam breach mechanisms. Considering all scenarios analysed here, the maximum dam breach flood wave has a difference of 4 m against the flood wave of spilling conditions downstream of the reservoir. This difference is reduced to 2 m when the flood wave propagates through the river. MacDonald and Langridge – Monopolis breaching mechanism with higher reservoir water levels at breach consistently produced the most severe outcomes, characterized by rapid breach formation, steep flood waves, and extensive inundation. The spatial and temporal variability observed in this study has significant implications for dam safety, emergency response planning, and floodplain management. The rapid flood wave propagation observed in MacDonald and Langridge – Monopolis methods's scenarios highlights the need for advanced early warning systems and robust evacuation plans to safeguard downstream communities.

Keywords: Dam Breach Analysis; HEC-RAS; Breaching Mechanisms; Dam Safety

ICSBE24_442

FLOOD IMPACTS DUE TO CASCADE DAM FAILURES

P.D.P.O. Peramuna[1,2*], N.G.P.B. Neluwala[1], K.K. Wijesundara[1], S. Venkatesan[2], S. De Silva[2], P.B.R. Dissanayake[1]

[1]Department of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka
[2]Department of Civil Engineering, Royal Melbourne Institute of Technology, Australia
**Correspondence E-mail: oshini.peramuna@eng.pdn.ac.lk, TP: +94717007190*

Abstract: Floods are the most disastrous and the most frequent type of natural hazard of the world whereas the third most frequent natural hazard is the earthquake. Hence, to mitigate rainfall generated floods, dams are built along the major rivers all around the globe creating cascade dam systems. On the other hand, if there is a failure in one of such dams, it might add more to build up the flash flood's destructive nature. In addition, the damage can be extensively propagated if the water flow cannot be contained by the downstream dams in a cascade dam system. Hence, at present, more attention is focused on the investigation of the behavior of flash floods generated by the cascade dam failures induced from earthquakes. This study is focused on the assessment of flood impacts due to the failure of the cascade dam system in the Mahaweli river basin, namely Kothmale, Victoria and Randenigala dams while considering the probability of occurrence of natural hazards. 2D unsteady flow models are developed for the study area to analyze the cascade effect of the dams for a hazard matrix that lead to different failure scenarios. The research analyzed the possible consequences that would occur to the community and as well as to the natural environment in vulnerable areas due to failures of dams caused by natural hazards under multiple scenarios. Furthermore, the presence of the concrete arch dam in the cascade dam system has improved the overall performance during an earthquake event, providing more resilience to the system. The results of the study will be useful for the responsible governing authorities and policy makers in compilation of disaster mitigation strategies.

Keywords: Cascade Dams; Earthquake; Flood; 2D Model

ICSBE24_060

COMPARISON OF FOUR ELECTRICAL RESISTIVITY ARRAYS TO STUDY THE SEEPAGE IN THISSA DAM, SRI LANKA

M.D.J.P. Wickramasooriya*
Irrigation Department, Sri Lanka
**Correspondence E-mail: janakapriyantha1986@gmail.com, TP: +94717160560*

Abstract: The Thissa Reservoir, located in Thissamaharama in the Hambantota District, approximately 250 km south of Colombo, Sri Lanka, is geologically situated within the Vijayan Complex litho-tectonic unit of the country. This earthen dam has a maximum height of 4.88 meters and spans approximately 1.5 kilometers, with a total maximum reservoir capacity of 4.32 million cubic meters. Primarily used for irrigation, the reservoir supports an irrigable area of about 1,113 acres. Over the recent years, seepage issues have raised concerns about the dam's safety. To address this, rehabilitation efforts included foundation treatments and a two-dimensional Ground Electrical Resistivity Survey (2D-GERS) alongside clay-cement grouting. The 2D-GERS method, a geophysical technique, was employed to detect subsurface anomalies, including seepage zones and grout injections. Four electrode array configurations - Dipole-Dipole, Gradient-XL, Schlumberger, and Wenner—were compared to evaluate their effectiveness in identifying seepage zones within the Thissa earthen dam. Although some of these arrays have been individually studied in previous researches, a comprehensive comparison of all four has been lacking. This study aimed to evaluate the performance of these arrays in detecting seepage zones post-treatment with clay-cement grouting. The analysis of 2D-GERS cross-sections combined with grouting data demonstrated that the 2D-GERS method is a cost-effective approach for assessing seepage in earthen dams. Grouting zones were clearly delineated by the array results, with the Dipole-Dipole array providing the most extensive data coverage (1,149 data points), capturing greater depths, and offering quicker data acquisition. In contrast, the Wenner array recorded the least data points (345) and was limited in depth penetration. The Gradient-XL (1,030 data points) and Schlumberger (748 data points) arrays produced profiles with similar effetiveness. However, the Dipole-Dipole array was found to be less sensitive compared to the other configurations. Notably, the Gradient-XL and Schlumberger arrays effectively captured grout intake at acceptable levels.

Keywords: Ground Electrical Resistivity Survey; Dipole-Dipole; Gradient-XL; Schlumberger; Wenner

ICSBE24_675

DAM BREACH ANALYSIS ON IMPACT OF BREACH PARAMETERS AND RESERVOIR LEVELS ON DOWNSTREAM FLOODS: CASE STUDY ON TABOWA RESERVOIR, SRI LANKA

D.A.R. Daranagama[1*], Panduka Neluwala[2]
[1]Department of Irrigation, Bauddaloka Mawatha, Colombo 07, Sri Lanka
[2]Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: ravindudaranagama@gmail.lk, TP: +94777917575*

Abstract: Dam Breaches are causing severe hazards in the downstream areas by generating destructive flash floods. This study analyses the impact of downstream floods due to piping failures of embankment dams. The Tabbowa reservoir in Sri Lanka was taken as a case study. Breach sections and parameters were estimated using four breaching mechanisms based on empirical equations: MacDonald and Langridge – Monopolis method, Froehlich method, Von Thun & Gillette method, and Xu & Zhang nethod. US Army Corps HEC-RAS was utilised to develop the hydrodynamic model which, assessed downstream flood characteristics under varying reservoir water levels for each breach mechanism. The results reveal a clear relationship between reservoir water levels at breach initiation and downstream flood severity. Higher reservoir levels lead to increased flood wave heights, more extensive inundation, and faster flood wave propagation. MacDonald and Langridge – Monopolis method show the highest variation of the breach flows against the reservoir water level at breach initiation among the four dam breach mechanisms. Considering all scenarios analysed here, the maximum dam breach flood wave has a difference of 4 m against the flood wave of spilling conditions downstream of the reservoir. This difference is reduced to 2 m when the flood wave propagates through the river. MacDonald and Langridge – Monopolis breaching mechanism with higher reservoir water levels at breach consistently produced the most severe outcomes, characterized by rapid breach formation, steep flood waves, and extensive inundation. The spatial and temporal variability observed in this study has significant implications for dam safety, emergency response planning, and floodplain management. The rapid flood wave propagation observed in MacDonald and Langridge – Monopolis methods's scenarios highlights the need for advanced early warning systems and robust evacuation plans to safeguard downstream communities.

Keywords: Dam Breach Analysis; HEC-RAS; Breaching Mechanisms; Dam Safety

ICSBE24_441

SEISMIC ANALYSIS ON CFR DAMS INCLUDING MATERIAL PARAMETER OPTIMIZATION

T.M.S.Tennekoon[1,2*], K.K. Wijesundara[1], S. Venkatesan[2], S. De Silva[2], P.B.R. Dissanayake[1], N.G.P.B. Neluwala[1]

[1]Department of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka
[2]Department of Civil Engineering, Royal Melbourne Institute of Technology, Australia
**Correspondence E-mail: sachintha1692@gmail.com, TP: +94712627598*

Abstract: Identifying the material parameters of existing rockfill dam structures is extremely important when conducting seismic analysis. With the limitations of the laboratory testing to be conducted at the site due to large particle size and the accessibility of the material, displacement-based back analysis methods are frequently adopted for this purpose depending on the availability of the dam deformations at the site. An optimization algorithm coupled with a machine learning model is generally adopted for this purpose where the optimum material parameters are identified to match the dam deformations. However, the accuracy of the machine learning models used has not been explicitly discussed in previous studies. Furthermore, the failure surface derivation of the rockfill material in concrete-faced rockfill dams remains uncertain. Therefore, this study focus on utilizing an advanced tree-based algorithm (Extreme gradient boosting) which is trained and tested for maximum accuracy in the particle swarm optimization including mutation to conduct back analysis of the rockfill material in the Kotmale concrete-faced rockfill dam. Furthermore, the possibility of failure surface generation through resulting stresses is investigated in this study. The accuracy of the tree-based model is evaluated compared to support vector regressor where clear variations can be noted and the hyperparameter tuning of the algorithm result in more accurate final output. In the seismic analysis, the derived failure surfaces were validated using the threshold deformation values defined in the literature.

Keywords: Back-analysis; Seismic-analysis; Machine learning; Optimization

ICSBE24_443

Dam Specific Seismic Hazard Analysis for Comprehensive Risk Assessment and Requalification of Dam for Updated Seismicity of the Region

P. Anbazhagan*, G. Silas Abraham
Department of Civil Engineering, Indian Institute of Science, Bangalore 560012, India
**Correspondence E-mail: anbazhagan@iisc.ac.in, TP: +918022932467*

Abstract: Floods are the most disastrous and the most frequent type of natural hazard of the world whereas the third most frequent natural hazard is the earthquake. Hence, to mitigate rainfall generated floods, dams are built along the major rivers all around the globe creating cascade dam systems. On the other hand, if there is a failure in one of such dams, it might add more to build up the flash flood's destructive nature. In addition, the damage can be extensively propagated if the water flow cannot be contained by the downstream dams in a cascade dam system. Hence, at present, more attention is focused on the investigation of the behavior of flash floods generated by the cascade dam failures induced from earthquakes. This study is focused on the assessment of flood impacts due to the failure of the cascade dam system in the Mahaweli river basin, namely Kothmale, Victoria and Randenigala dams while considering the probability of occurrence of natural hazards. 2D unsteady flow models are developed for the study area to analyze the cascade effect of the dams for a hazard matrix that lead to different failure scenarios. The research analyzed the possible consequences that would occur to the community and as well as to the natural environment in vulnerable areas due to failures of dams caused by natural hazards under multiple scenarios. Furthermore, the presence of the concrete arch dam in the cascade dam system has improved the overall performance during an earthquake event, providing more resilience to the system. The results of the study will be useful for the responsible governing authorities and policy makers in compilation of disaster mitigation strategies.

Keywords: Cascade Dams; Earthquake; Flood; 2D Model

ICSBE24_035

ASSESSMENT OF THE STATUS OF THE HIKKADUWA MARINE SANCTUARY

D. P. C. Laknath[1], T.U.S. Manamperi[2]*, H.P.G.M. Caldera[3], K.K.P.P. Ranaweera[4]

[1] Lanka Hydraulic Institute Ltd. Sri Lanka
[2] Swansea University, The United Kingdom
[3] National Institute of Scientific Research, University of Quebec, Canada
[4] Ceylon Fishery Harbour Corporation, Sri Lanka
** Correspondence E-mail: tharindu.udasri@gmail.com, TP: +94718732276*

Abstract: Hikkaduwa Marine Sanctuary is located in the Hikkaduwa National Park in the Southern province in Sri Lanka. This national park is well known for its fringing coral reef which has a high degree of biodiversity. The area was declared as a wildlife sanctuary in 1979 and then upgraded to a nature reserve in 1988. Tourism-centered anthropogenic activities and natural climatic conditions caused extensive degradation of corals in the Hikkaduwa Marine Sanctuary, and some factors are still continuing to degrade the natural live corals and other marine habitats. Ongoing or proposed marine and coastal-related development activities in the vicinity of Hikkaduwa National Park would have impact on the marine life, including the corals in the Marine Sanctuary. From an extensive review of past studies and field investigations conducted by NARA in 1985, 1992 and 1994, it was identified that during the time from 1985 to 1994, the total live coral cover has significantly increased (i.e. 18.8%, 22%, and 34% of live coral) except in an area where significant disturbances caused by boat anchoring before the construction of Hikkaduwa Fishery Harbour which is the northern boundary of the present Hikkaduwa National Park. The live coral percentage was consistently increasing from 7% following the natural hazard of El Nino event in Indian Ocean in 1998, up to 15% until 2004, amid the rehabilitation of Hikkaduwa fishery harbour and its commencement of operations from 2001. After 2007, sufficient investigations have not been carried out to assess the status of the corals in Hikkaduwa Marine Sanctuary. Hence, a comprehensive study to investigate the present status of corals in Hikkaduwa National Park is required to carry out to identify the baseline status of corrals and other marine habitats before implementing marine/coastal related development projects in the vicinity of Hikkaduwa Marine Sanctuary.

Keywords: National Park; Reef Lagoon; Live Coral; Fishery Harbour; Re-development

ICSBE24_047

DEVELOPMENT AND FINITE ELEMENT ANALYSIS OF VISCOELASTIC TUNED MASS DAMPERS FOR MITIGATING EXCESSIVE WALKING-INDUCED VIBRATIONS IN STRUCTURES

S.A.S. Madhushan*, A.P.R.L. Rathnayaka, H.A.D.S. Buddika
Faculty of Engineering, University of Peradeniya, Peradeniya, 20400 Sri Lanka
**Correspondence E-mail: sumeeramadhushan96@eng.pdn.ac.lk, TP: +94702130249*

Abstract: Excessive vibrations in structures due to human activities, like walking, running, dancing, and jumping, not only cause discomfort but also jeopardize structural health and stability. Constraints in space, high costs, and design complexity challenge typical solutions including enhanced floor stiffness, active control devices, and mechanical dampers. The design of a tuned mass damper employing less cost viscoelastic materials like rubber will improve the efficiency to address these challenges. This work focuses on designing, finite element modeling, and testing viscoelastic dampers for a real-life structure using ANSYS software for perfect control over walking-induced vibrations. To ensure correct finite element modeling, prototypes were modeled and evaluated against existing literature. Current strategies were validated using walking force along with a novel ANSYS technique for force delivery along the length of the structure. Multiple tuned mass dampers, utilizing commercially available materials, were then designed for a real-life structure. The acceleration response of the structure was an impressive 88% drop from 1.5 m/s^2 for structure without dampers to 0.18 m/s^2 with multiple dampers for the same applied force. The application of various single and group walking forces evaluates the efficiency of the dampers even more. This study guarantees occupant comfort and structural integrity by applying effective and low-cost solutions for reducing vibrations induced by human activities in structures.

Keywords: Vibrations; Tuned Mass Damper; Viscoelastic Materials; Finite Element Modelling; Structural Health

ICSBE24_039

EVALUATION OF PASSIVE COOLING SOLUTIONS TO MITIGATE THE COOLING LOAD DEMAND FOR EXISTING BUILDINGS IN TROPICAL CLIMATES

I.H.U.S. Hettiarachchi*, V.W.A.D. Uthpala, A.S.R. Gnanarathna, Indrajith Nissanka

Department of Mechanical Engineering, University of Moratuwa, Katubedda, Sri Lanka
**Correspondence E-mail: hettiarachchiihus.19@uom.lk, TP: +94767577013*

Abstract: This paper investigates the potential use of natural ventilation methods, an important aspect of passive cooling, to mitigate the ever-increasing cooling energy demand for buildings in tropical climate regions. In this study, three different zones from three distinct buildings were selected to cover various characteristics of different building architectures. Six natural ventilation strategies were tested for each zone by altering the placements of windows and vents to evaluate potential energy savings for cooling energy usage. The proposed arrangements were simulated using DesignBuilder software to assess their effectiveness in terms of thermal comfort, fresh air supply rate, and energy savings. The strategies incorporated single-sided, cross, and stack ventilation methods wherever possible. The percentage of discomfort hours was used to estimate the need for a mechanical ventilation system in the naturally ventilated zones. The thermal comfort assessment utilized the adaptive equations for naturally ventilated buildings as specified in ASHRAE 55. Moreover, each natural ventilation strategy was simulated for the projected outdoor climate conditions of years 2030 and 2050, in addition to the current climate scenario, to explore their effectiveness against climate change impacts. The results showed that use of natural ventilation strategies could save significant amounts of electricity needed for mechanical ventilation systems. However, incorporating all possible natural ventilation methods provides better results in terms of thermal comfort and energy savings. The study results indicate that utilizing natural ventilation strategies could reduce energy consumption by up to 16 %.

Keywords: Natural Ventilation; Adaptive Thermal Comfort; Building Energy Simulations; Climate Change Impacts.

ICSBE24_083

ENVIRONMENTAL IMPACT DUE TO CO_2 EMISSION CAUSED BY CONCRETE ELEMENTS OF DOMESTIC CONSTRUCTION PROJECTS

A.S.H. Silva[1*], K. Guruge[2], P. Coomasaru[3]
[1]*Southern Fire (Pvt)Ltd, 400/70 Seeduwa Village, Seeduwa*
[2]*Department of Building Economics, University of Moratuwa, Katubedda*
[3]*Department of Quantity Surveying, Faculty of Engineering,*
Sri Lanka Institute of Information Technology, Malabe
**Correspondence E-mail: shalyasilva96@gmail.com, TP: +94768673277*

Abstract: Construction industry contributes 39% for the global CO_2 emission. According to the past studies, concrete elements are utilized more energy and emitted more CO_2 relatively to other building elements. In both Operational Carbon emission and Embodied Carbon emission, concrete elements take the first place among all other construction elements. As a consequence, it is important to understand the environmental impact due to CO2 emission caused by concrete elements. Therefore, this study aims to define the environmental impact due to CO_2 emission caused by concrete elements of domestic construction projects. In order to achieve the aim, objectives of the study are listed as to understand the CO_2 emission of global construction sector, to identify the environmental impact due to CO_2 emission and to examine the environmental impact due to CO_2 emission caused by concrete elements in domestic construction projects. Thus, the research carried out as a quantitative approach and both primary and secondary data was collected. First and second objectives were derived using literature review and validated using a questionnaire survey. By using the same questionnaire survey final objective was fulfilled. The study found that Building and Construction together record 39% of energy related CO_2 with operational emission representing 28% and the remaining 11% originates from embodied carbon emission. Global warming and climate change are the significant impacts caused due to CO_2 emission. The huge amount of CO_2 emission of concrete production process generates when manufacturing cement.

Keywords: CO2 Emission; Concrete Elements; Construction Industry; Sri lanka; Environmental Impact

ICSBE24_131

TOWARDS ECO-URBANISM: EXPLORING THE NEXUS OF SUSTAINABLE ARCHITECTURE AND WASTE MANAGEMENT IN COLOMBO, SRI LANKA

M.A.D.D. Mudannayaka*, Jeeva Wijesundara
SLIIT School of Architecture
**Correspondence E-mail: dulamudannayaka@gmail.com, TP: +94775856747*

Abstract: The rapid urbanization of Colombo, Sri Lanka, has posed significant challenges in terms of environmental sustainability, particularly in the realms of architecture and waste management. This research endeavours to explore the intricate relationship between sustainable architecture and waste management practices within the context of Colombo's urban landscape. The primary issue addressed is the escalating environmental degradation resulting from unsustainable urban development patterns and inadequate waste management systems. The objective of this study is to assess the potential of eco-urbanism as a holistic approach to mitigating these challenges by integrating sustainable architectural principles with efficient waste management strategies. Employing a mixed-methods approach, the research involves qualitative analysis through interviews and case studies to understand current practices and challenges, supplemented by quantitative data collection to measure the environmental impact and effectiveness of existing initiatives. By examining key indicators such as energy efficiency, waste reduction, and community engagement, the study aims to provide insights into the feasibility and effectiveness of eco-urbanism in Colombo. The findings of this research are expected to contribute to the body of knowledge on sustainable urban development, offering practical recommendations for policymakers, urban planners, architects, and waste management authorities. Ultimately, the research endeavours to demonstrate that the integration of sustainable architecture and waste management is not only desirable but imperative for fostering a greener and more resilient urban environment in Colombo, Sri Lanka.

Keywords: Eco-urbanism; Sustainable Architecture; Waste Management; Energy Efficiency

ICSBE24_692

DEVELOPMENT OF A GREEN RATING SYSTEM FOR A SUSTAINABLE INDUSTRIAL ZONE

D.M.V.D. Gunathunga[1], S.H. Kolambage[2], P. Gajanayake[1*], H.G.T.P. Samarawickrama[3], P.B.R. Dissanayake[4], Y.G.D.P. Wijewardana[5]

[1]Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka
[2]Faculty of graduate studies, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka
[3]Board of investment of SriLanka, WTC West Tower, Echelone Square, Colombo, Sri Lanka
[4]Green Building Council of Sri Lanka, Colombo 07, Sri Lanka
[5]Faculty of Graduate Studies, University of Colombo, Sri Lanka
**Correspondence E-mail: pradeepgajanayake@sjp.ac.lk, TP: +94771522444*

Abstract: This study reviews sustainable industrial zones in Sri Lanka, establishing guidelines for a rating system to evaluate environmental performance. The tool aims to reduce environmental impact and serve as a standard for sustainable practices, with a pilot assessment study to ensure its effectiveness. A set of seven criteria were identified as the benchmark of the assessment tool as management, sustainable zone, infrastructure management, waste management, sustainable energy usage, sustainable recognize cooperate social responsibility (CSR) and innovation. Under each main criterion, sub-criteria (SC) were identified in driving the converted conventional industrial zone to the sustainable industrial zone. The SC found under management were whether the industrial zone an approved under environmental impact assessment (EIA)or initial environmental examination (IEE) or environment recommendation, eco vision of the industrial zone, information and communications technology application for green industrial zone and integrated planning. For the sustainable zone, erosion control and landscape management, conserve natural resources, reduce heat island effect and eco- friendly transportation were identified as SC. Next SC were identified concerning the infrastructure management, noise and vibration reduction, air pollution reduction, preserve archeological sites and heritage buildings and fire and security further, SC was recognized under waste management as solid waste management, wastewater treatment and hazardous waste management. Under sustainable energy usage, SC were perceived as encourage to use of renewable energy, greenhouse gas emissions, minimize the energy usage. Two SC were determined under sustainable social and cultural activities as substandard as recognize corporate social responsibility (CSR) with sustainability focus and welfare of women and children. Finally, innovations in operations and exemplary performance are the factors classified under Innovation. This study reviews sustainable industrial zones (SIZ) in Sri Lanka, proposing a comprehensive rating system to evaluate their environmental performance, aiming to increase awareness of green practices and establish a sustainable standard.

Keywords: Sustainable Industrial Zone; Environmental Impact Assessment; Initial Environmental Examination; Sustainable Energy Usage; Sustainable Recognize Cooperate Social Responsibility (CSR)

ICSBE24_092

GREEN BUILDING PRACTICES IN THE SRI LANKAN HOTEL SECTOR

Suvimali Rathnayake[1*], Julia N. Albrecht[1], Tobias Danielmeier[2]
[1]*Department of Tourism, University of Otago, Dunedin, New Zealand*
[2]*School of Architecture, Otago Polytechnic, Dunedin, New Zealand*
**Correspondence E-mail: suvimali.rathnayake@postgrad.otago.ac.nz, TP: +94775887110*

Abstract: To mitigate the environmental impacts caused by the accommodation sector, the hospitality industry has resorted to the concept of green hotels by implementing various green practices. Green certification is vital in validating these green efforts and providing hotel assurance. Although two types of green certifications are mainly used in the hotel industry for buildings and operations, hotels give more priority to obtaining operational certifications. This is because hotel prioritises their business operations while building design is less considered. According to the databases of respective certification bodies, it can be identified that hotels in Sri Lanka are similarly prioritising operational-related certifications, resulting in fewer green building-certified hotels. The Sri Lankan government has realised that green building is a crucial aspect of the tourism industry in mitigating environmental effects, and it is expected to enforce green building guidelines for all new constructions and refurbishments in the tourism sector. As building design is a critical factor in greening hotels, this research aims to investigate the green building practices in certified hotels in Sri Lanka based on green building certification criteria. This research is expected to utilise a multiple case study strategy, and cases will be selected through the purposive sampling method. Direct observations, semi-structured interviews, and document analysis will be the primary data-collecting methods. Secondary data will be collected from reliable textbooks, records of government bodies, journal articles, and websites, and the collected data will be analysed using thematic analysis. The findings of this research will address the research gap in the existing hospitality literature in both the global and Sri Lankan contexts.

Keywords: Green Building Certification; Green Hotel; Building Practices; Sri Lanka

ICSBE24_025

BUILDING A GREENER FUTURE: SYSTEMATIC REVIEW OF SUSTAINABLE CONSTRUCTION MATERIALS AND TECHNOLOGIES FOR EMISSION REDUCTION

M.A.D.K. Jayathilaka[1*], H.A.T.N. Perera[2], G.Y. Jayasinghe[1]

[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Matara-Kamburupitiya Rd, 81100, Sri Lanka

[2]Department of Environmental Engineering, Faculty of Earth Science and Environmental Engineering, University of Miskolc, 3515, Miskolc, Hungary

**Correspondence E-mail: jayathilaka11gt@ags.ruh.ac.lk, TP: +94766875639*

Abstract: The construction industry accounts for 39 % of the global greenhouse emissions from energy consumption and therefore can greatly facilitate the fight against climate change. This review focused on assessing sustainable material options and technologies in the construction industry to reduce CO_2 emission and inform policy and practice changes. Following the PRISMA guidelines, 20 articles in English were identified from 2000 to 2024 on Google Scholar and Research-Gate using the keywords, 'Circular-Economy', 'Emission-Reduction', 'Energy-Efficiency', 'Green Building-Techniques', 'Innovative-Materials', and 'Sustainable-Construction' with "AND", "OR" Boolean gates. Geothermal systems reduce energy use and CO_2 emissions when retrofitted to all-air (heating, ventilation, and air conditioning) HVAC systems; Green roofs reduced energy consumption by 40. 1% and 10. 3% on malls and apartment buildings respectively in Shanghai. Low-emissive paints lowered heating power demands by 36 % and thereby improved the total energy efficiency of buildings in 13%. Cementitious-glass matrix (CGM) bricks are a low-carbon option that can save up to 85 % and 33 % in carbon emissions and energy use compared to conventional bricks. Green building materials included foam heat-insulating bricks made from waste oyster shells and helped to reduce CO_2 emissions by 48 %. Various methodologies of sustainable construction eliminate CO_2 emission to different extents and the application of CGM bricks and bamboo reduces 30 % in emission; the use of green roofs, geothermal HVAC systems energy saves up to 18 %. Bamboo (*Bambusa vulgaris*) is the superior material from both environmental and functionality perspectives. The circular economy approach works for sustainable practices as fly ash mixed with natural clay results in green products, and the use of local material leads to a 69 % reduction in transportation emissions and a 16 % boost to local economies. Further work should concentrate on known and creating governmental policies and stimulating measures essential for demonstrating the direction to the construction industry.

Keywords: Circular Economy; Emission Reduction, Energy Efficiency; Green Building Techniques; Innovative Materials; Sustainable Construction

ICSBE24_032

APPLICATION POTENTIAL OF COTTON TEXTILE ASH WASTES FROM BIOMASS BOILERS AS AN ALTERNATIVE RAW MATERIALTO DEVELOP BRICKS

W.M.C.S. Wijesingha*, A.K. Jeewandara, T.T. Chitrananda
Department of Applied Computing, Faculty of Computing and Technology, University of Kelaniya, Sri Lanka
**Correspondence E-mail: cshimalka@gmail.com, TP: +94710476258*

Abstract: The textile and apparel industries generate a significant amount of industrial waste worldwide annually as compared to other industries. In Sri Lanka, garment manufacturing is the leading and single-biggest industry that plays a vital role in the economy. Using textile waste as raw material for boilers with biomass is now practiced in the apparel industry. Fulfilling the thermal energy requirement is a fundamental requirement of the apparel sector. Therefore, few apparel manufacturing companies in Sri Lanka are currently practicing the use of cotton waste for biomass boilers as an energy source. Focusing on boiler ash waste management, there is potential to utilize this waste in the construction sector because, with constant population growth, there is a need for new and efficient building materials. Bricks, a primary wall-building material, could be developed using textile ash. The objective of this project was to evaluate the application potential of textile ash as an alternative raw material to develop bricks for the construction sector. Compressed soil interlocking bricks were used to test ash samples, and textile ash waste was replaced with Portland cement and soil. Cement was replaced by 10 % 20 % 30 % and soil was replaced by 5 % 10 % 15 % from ash. Physical properties were tested such as compressive strength, density, and water absorption. Also, the thermal insulation of compressed textile ash waste soil bricks was measured compared to concrete bricks using model houses. The result showed that all brick ratios fulfilled the basic standard to use construction sector brick as a wall-building material. Also, textile ash waste soil bricks showed better insulation properties compared to concrete bricks and textile ash waste soil bricks are a lightweight composite that can be used in making bricks and panels with good insulation properties while satisfying the strength requirements.

Keywords: Textile Waste; Compressed Earth Brick; Thermal Insulation; Boiler Ash

ICSBE24_067

INVESTIGATION OF BOND STRENGTH BEHAVIOUR BETWEEN CONCRETE AND KITHUL TIMBER REBAR USING PULL OUT TEST

K.I.S. Kodithuwakku*, I.S.K. Wijayawardane
Department of Civil Engineering, The Open University of Sri Lanka, Nawala, Nugegoda.
**Correspondence E-mail: isurajeesaranga@gmail.com, TP: +94714802981*

Abstract: In a low-income country like Sri Lanka, the cost of construction materials is very high relative to income levels. As a result, many partially constructed houses can be seen. This is primarily due to the reliance on traditional construction materials and the lack of introduction of cost-effective materials. Kithul timber (Caryota Urens) is one such material that can be used as the distribution reinforcement in one-way spanning concrete slabs due to its strength, durability, and cost-effectiveness. This study investigates the feasibility of using Kithul timber rebar instead of traditional steel distribution bars by examining the bond strength. Kithul timber rebars were produced from the heartwood portion of the Kithul tree. The mechanical properties of Kithul timber were determined by the BS 373:1957 standard. Pull-out tests were conducted on Kithul timber rebars embedded in concrete of three different concrete grades (C20, C25, and C30) after curing for 28 days. Two different shapes and different sizes of Kithul rebars were tested, including square rebars (10 mm x 10 mm, 12 mm x 12 mm, and 16 mm x 16 mm) and circular rebars (12 mm, 16 mm, and 20 mm diameter). According to the experimental results, for the selected sizes and grades of concrete, the bond strength varies from 2.76 MPa to 5.05 MPa for square-shaped Kithul rebar and from 3.64 MPa to 6.73 MPa for circular-shaped Kithul rebar. Therefore, the experimental results indicate that the specimens that have embedded circular-shaped Kithul rebars have approximately 27% higher bond strength compared to specimens with square shapes. Furthermore, the bond strength of both shapes of rebars(circular and square) increases with the concrete grade.

Keywords: Kithul Timber Rebar; One Way Spanning Slab; Distribution Reinforcement; Traditional Construction Materials; Cost Effective Materials; Pull Out Test; Bond Strength

ICSBE24_094

IMPROVING THE PERFORMANCE OF EXISTING COMMERCIAL BUILDINGS ACCORDING TO THE GREEN BUILDING GUIDELINES IN SRI LANKA

H.H.A. Vithanage, M.A. Wijewardane*
Department of Mechanical Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: anusha@uom.lk, TP: +94716432066*

Abstract: Recent rapid developments in the world have surged global energy consumption, forcing economies and the environment to their knees. Rise in energy use, more so from buildings, greatly contributes to the current energy crisis that is powered by a gap between future energy supply and demand. Inefficient consumption practices enhance energy wastage; therefore, energy conservation is important in reducing expenses and environment related harm. Notably, the concept of sustainable development has been on the rise, especially on the development of green buildings. For instance, these buildings are not only resource efficient, making efficient use of electricity, water, and land, among other resources - but also maximize occupants' health, comfort, and productivity while at the same time ensuring long-term economic benefits. The green building movement is a process that is guided by some of the tenets from the Leadership in Energy and Environmental Design (LEED) program. This includes six core principles outlined by LEED, which are: sustainable siting; water efficiency; energy efficiency; material and resource use; indoor climate quality; and efficient commissioning, operation, and maintenance. The research evaluate and proposes a roadmap for existing commercial buildings at different ages (5-years old, 10-years old and 15-years old) to achieve the minimum standard recommended by the Green Building Council of Sri Lanka. The study was conducted based on nine functioning buildings followed by a survey, walk-through energy audit and techno-economic feasibility on retrofitting options to obtain the green building certificate. It was found that the age of buildings plays a crucial role in obtaining the green building ratings to achive the acceptable levels. Older structures typically featuring less efficient systems than newer constructions equipped with modern technologies. Occupant behavior significantly impacts the overall energy use, highlighting the importance of efficient building design, systems, and operational practices in reducing energy consumption.

Keywords: Commercial Buildings; Green Buildings; Energy Efficiency; Energy Management; Sustainable Development; GREENSL Rating System

ICSBE24_090

MITIGATING EMBODIED CARBON: CARBON ASSESSMENT CHALLENGES AND METHODS IN SMART BUILDING CONSTRUCTION IN THE UK

Harshi Bamunuachchige*, Min An
University of Salford, School of Science and Engineering, United Kingdom
**Correspondence E-mail: h.m.bamunuachchige@edu.salford.ac.uk*

Abstract: The UK built environment sector is confronted with significant challenges in reducing greenhouse gas emissions to meet the net zero 2050 targets. Currently, the built environment sector accounts for 40 % of carbon emissions globally, about 39 % of UK carbon emissions stemming from construction activities. Despite ongoing efforts, carbon emissions levels in the built environment sector remain exceedingly high. Therefore, in order to address this issue, this research paper aims to identify the carbon assessment challenges in the built environment sector and mitigate embodied carbon in building construction. A systematic literature review will first be employed to investigate the critical challenges to balancing environmental management in smart building construction. Subsequently, an expert interview will be conducted to gather deeper insights. Reducing embodied carbon emissions in the construction of smart buildings presents a variety of intricate issues. These include rising building prices, a lack of low-carbon materials readily available, insufficient government regulations, opposition to novel building materials, a scarcity of experts with an environmental conscience, and a failure to include low-carbon elements in early project stages. These problems are made worse by the absence of rigorous carbon management strategies and environmental impact studies at the project's inspection. The literature suggests the drivers for effective embodied carbon management within the UK built environment sector to tackle the identified challenges. The recommendations are expected to mitigate the negative environmental impacts and drastically cutting embodied carbon emissions. Therefore, this study demonstrates that the built environment sector can make significant progress towards a low-carbon economy and the achievement of net zero 2050 targets.

Keywords: Embodied Carbon; Environmental Impact Assessment; Carbon Emissions; Net Zero; Greenhouse Gas Emissions

ICSBE24_111

A COMPARATIVE ANALYSIS OF ENERGY EFFICIENCY OF MODULAR HOUSES IN SRI LANKA

T.I. Munmulla[1*], S.S. Bandaranayake[2], S. Navaratnam[2], H.D. Hidallana Gamage[1], M.T.R. Jayasinghe[1], G. Zhang[2]

[1]Department of Civil Engineering, University of Moratuwa, Moratuwa 10400, Sri Lanka
[2]School of Engineering, RMIT University, Melbourne 3000, Australia
**Correspondence E-mail: munmullati.21@uom.lk, TP: +9491223236*

Abstract: Modular construction can be utilised to develop a sustainable solution for the rising demand for affordable housing in Sri Lanka, coupled with escalating material and construction costs. Therefore, this study explores the necessity of affordable modular housing in Sri Lanka where a shortage of 2.4% of houses was observed. A comparative analysis of the energy consumption of the selected modular and conventional houses across the three distinct climatic zones (Colombo, Anuradhapura, Kandy) will also be conducted to identify the energy efficiency of the affordable modular house via energy simulation. The results showed that in Colombo modular construction could save up to 13.8% in annual energy consumption when compared with conventional houses. The energy savings is much higher for Anuradhapura and Kandy which are respectively 16.4% and 19.1%. The findings underscore the importance of adopting modular construction to address housing deficiencies in Sri Lanka, offering recommendations for policymakers and stakeholders to enhance energy efficiency and affordability in the housing sector.

Keywords: Modular Construction; Affordable Housing; Energy Efficiency; Sustainability; Sri Lankan Construction

ICSBE24_115

DEVELOPMENT OF A MOBILE AUGMENTED REALITY APPLICATION TO ENHANCE YOUTH ENGAGEMENT IN PLACEMAKING

R.A.D. Ranasinghe[1*], R. Mahamood[1], M.C.K. De Silva[1], N. Kankanamge[2], N. Kangana[1]

[1]University of Moratuwa, Katubedda, Sri Lanka
[2]University of Sunshine Coast, Queensland, Australia
**Correspondence E-mail: madumadhirad.23@uom.lk , TP: +94711245672*

Abstract: The urban planning field is confronted with the challenge of integrating diverse community perspectives into the decision-making process. Throughout the history of urban development, the role of planning and designing public spaces has been limited to professionals. Later on, conventional participatory planning techniques (hand drawings, manual mapping, public hearings) were applied, but these approaches had limitations and less interaction with communities. Due to the development of Human-Computer Interaction (HCI) and digital technology, the use of technical methods such as Geographic Information Systems (GIS), 3D modeling and visualization tools, Virtual Reality (VR), and Augmented Reality (AR) for the planning process has been identified. The objective of this study is to develop a mobile augmented reality application that promotes and improves the involvement of youth in placemaking, specifically in the Sri Lankan context. City BuildAR is a mobile AR application developed by the authors using Unity Real-Time Development Platform and the app is developed for an Android Operating System. An initial app demonstration was conducted with the urban planning undergraduates of the University of Moratuwa to design the university cafeteria. The results of the demonstration emphasized that AR is an effective platform for encouraging people to engage in placemaking activities. According to their feedback, mobile AR is considered to be more user-friendly, manageable, and easy to access compared to current participatory planning methods. The study's findings suggest that AR technology has significant potential as a tool for participatory planning, especially to enhance youth engagement in placemaking.

Keywords: Mobile Augmented Reality; Placemaking; Youth Engagement; Participatory Planning; Public Spaces

ICSBE24_201

A COMPREHENSIVE STUDY ON THE DRAWBACKS IN THE OPERATIONS AND MAINTENANCE PROCESSES OF SCHOOL BUILDINGS IN SRI LANKA

B.R.W.M.D. Thoradeniya, C. Jayasinghe, I.E. Ariyaratne
Department of Civil Engineering, University of Moratuwa, Colombo, Sri Lanka
**Correspondence E-mail: brwmd.thoradeniya@gmail.com, TP: +94715924796*

Abstract: The quality of educational infrastructure plays a pivotal role in fostering a conducive learning environment and promoting student wellbeing and academic success. The built environment of schools significantly influences the learning experience, and when buildings are not operated and maintained for optimal performance, it negatively impacts their functionality, value, appearance, and durability. Ensuring proper operations and maintenance is therefore critical to optimal preserving the performance of school buildings. Despite its importance, the Sri Lankan educational system has been found lacking in this aspect. In this study, a comprehensive investigation was conducted to assess the current state of the operations and maintenance processes of school buildings in Sri Lanka, identify the drawbacks and challenges faced, and provide recommendations for improvement. A structured questionnaire was utilized and distributed to 40 respondents, including schoolteachers, parents/guardians, members of old pupils' associations, and engineers/architects involved with school buildings in Sri Lanka, to gather relevant data. Following an in-depth analysis, the study identified common drawbacks including the absence of systematic, regular maintenance and insufficient funding for operations and maintenance work and recommendations. The findings of the study aim to evaluate and improve current practices, ultimately enhancing the quality of educational facilities and the overall functionality of the educational system in Sri Lanka.

Keywords: Maintenance; Operations; Performance; School Buildings

ICSBE24_205

GREEN BUILDING RATING SYSTEMS: INSIGHTS FOR IMPLEMENTING SUSTAINABLE BUILDING PRACTICES IN SRI LANKA

S.D.S.A. Wijerathna[1*], H.K.G. Punchihewa[1], M.M.I.D. Manthilake[1], H.P. Karunathilake[2]

[1]Department of Mechanical Engineering, University of Moratuwa, Moratuwa 10400
[2]Division of Physical and Computational Sciences, University of Pittsburgh, 300 Campus Drive, Bradford, USA
**Correspondence E-mail: wijerathnasdsa.22@uom.lk, TP: +94778570826*

Abstract: The construction industry is a significant contributor towards environmental degradation. To address this, Green Building Rating Systems (GBRSs) have emerged. However, the effectiveness of these systems varies across countries and their alignment with specific regional contexts is often lacking. Thus, the aim of this study was to determine criteria for the development of a sustainable office building rating system tailored for tropical climates. In this pursuit, thirteen GBRSs being used in different geographical regions were studied by analysing their credit structures and distributions. The findings revealed that the present GBRSs emphasise on different aspects of sustainability, and substantial variations in credit availability are present among them. While systems like BREEAM offer a more comprehensive framework, others, such as the International Green Building Council (IGBC), focus more on core environmental criteria. The research proposes a categorisation of the aspects of sustainability of office buildings into four overarching themes: 'Resource Utilisation Efficiency', 'Health and Safety', 'Climate Risk', and 'Biodiversity and Ecosystem'. These criteria provide a foundation for the development of a more holistic GBRS that can be easily adapted to the local context. By understanding the strengths and weaknesses of existing systems, this research contributes to the development of a tailored sustainable office building rating system for tropical countries, addressing their unique challenges and promoting environmentally responsible construction practices. These findings also contribute towards the development of effective sustainable office building design strategies for the topical countries and beyond.

Keywords: Green Building Rating Systems; Sustainability; Credit Structure; Environmental Impact

ICSBE24_641

CONSUMER'S PREFERENCE FOR PURCHASING PLACE FOR VEGETABLES IN WESTERN PROVINCE OF SRI LANKA

K.R.B.M.M.K. Ekanayake*, P.M. Kavindi, J.C. Kaushalya, U.G.H. Rakshani, N.M.H.I. Nayakarathne
Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
**Correspondence E-mail: krbmmkekanayake@std.agri.sab.ac.lk, TP: +94718525173*

Abstract: A majority of Sri Lankans include vegetables in their daily diet. Consumer preferences significantly influence vegetable purchasing decisions, impacting the supply chain and policymaking. This study investigated the factors influencing vegetable purchasing place selection among consumers in Sri Lanka's Western Province. The objectives were to investigate the factors influencing the choice of vegetable purchasing places and to assess consumer satisfaction with these venues. The study employed a self-administered questionnaire from 131 respondents across the Western Province. Descriptive statistics were used to identify the factors influencing their choices among supermarkets, greengrocers, small retail shops, fairs, and direct-from-farmer markets. The findings indicate that freshness, price, variety, hygiene, custom services, appealing place to buy, extra services, and convenience are significant determinants in the decision-making process. Supermarkets are preferred for their convenience and competitive pricing, while greengrocers and direct-from-farmer markets are favored for their freshness and trustworthiness. The study also revealed that 34.4 % of respondents preferred purchasing vegetables from greengrocers, followed by 26.7 % from small retail shops, 19.1 % from organized supermarkets, and 19.1 % from fairs. Factors such as freshness (81.7 %), lower prices (67.2 %), and variety (43.5 %) emerged as the most influential in choosing a purchasing place. Hygiene was also a significant consideration for 58% of respondents. Preferences for packaging leaned towards biodegradable or eco-friendly options (40.5 %). These findings can guide retailers, market organizers, and policymakers in aligning strategies with consumer demands, improving food security, and promoting sustainable practices.

Keywords: Consumer Behavior; Patterns in Purchasing; Vegetables; Market Preference

ICSBE24_044

THE SURVIVAL STRATEGIES FOR CONSULTANT QUANTITY SURVEYORS TO SUCCEED FROM ECONOMIC CRISIS

G. Namashivayam[1*], W.M.C.L.K. Wijekoon[2], P.H.Y. Buddhini[3]
[1]Eastern Asphalt and Mixed Concrete Company W.L.L, Bahrain
[2]Department of Quantity Surveying, Faculty of Engineering, SLIIT, New Kandy Road, Malabe, Sri Lanka
[3]Arch International (Pvt) Ltd, No 275, Nawala Road, Nawala
**Correspondence E-mail: phyashodhabuddhini@gmail.com, TP: +94779895606*

Abstract: The economic crisis in Sri Lanka has precipitated substantial challenges within the construction industry, including project delays, cancellations, and widespread job losses. This research aims to identify and analyze effective survival strategies for consultant quantity surveyors during such economic downturns. Utilizing a combination of professional responses and semi-structured interviews, this study systematically uncovers and evaluates these strategies. The approach involved conducting comprehensive interviews with industry professionals to gather insights on tactical responses to the economic crisis. Key strategies identified include enhancing marketing efforts, pursuing multiple projects simultaneously, and extending services to international markets such as Middle – East Countries, Australia, and New Zealand, where financial stability persists. Notably, 85 % of respondents emphasized the importance of marketing to increase client awareness, while 71 % advocated for managing multiple projects to ensure continuous turnover and effective overhead management. Additionally, 57.14 % supported engaging in numerous projects even at minimal profit margins to maintain cash flow. The research also highlighted the significance of building strong client relationships, with 42 % of participants recommending personalized service approaches to instill confidence and loyalty. Furthermore, fostering connections with fellow consultancy firms to gain project referrals, though mentioned by less than 15 % of respondents, was noted as a supplementary strategy. Investing in computer-based software emerged as a critical recommendation, enhancing efficiency, accuracy, and overall productivity. The study underscores the necessity for prediction and forecasting based on past experiences to better anticipate and mitigate the impacts of economic downturns. The findings of this research provide a comprehensive framework of multifaceted strategies essential for the sustainability and growth of consultant quantity surveying firms in Sri Lanka during economic crises. By adopting robust marketing efforts, engaging in international projects, managing client relationships, and leveraging technological advancements, these firms can navigate economic challenges more effectively.

Keywords: Consultant Quantity Surveyors; Economic Crisis; Construction Industry; Survival Strategy

ICSBE24_072

UNIAXIAL COMPRESSIVE RESPONSE OF CONCRETE WITH COMMUNICATION CABLE WASTE UNDER VARYING LOADS

M.N.M. Nifal[1], H.M.C.C. Somarathna[1,2*], I. Pithurjan[1], K. Satkunananthan[1]
[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka
[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: This investigation was designed to explore the uniaxial compressive behaviour of concrete integrated with communication cable waste across a range of loading conditions. The study sought to assess the viability of partially substituting coarse aggregate in concrete with a volume ratio of 10 %. Specimens prepared according to these specifications were subjected to compressive testing under varied loading scenarios. The concrete specimens, having matured for 28 days, were tested across three distinct cross-head speeds, 1, 20, and 200 mm/min to induce varying strain rates reflective of diverse loading conditions. The ensuing stress versus strain profiles generated from these tests were examined and used to study the effects of different strain rates on key compressive properties, including ultimate stress, strain at ultimate strength, energy absorption at ultimate strength, and fracture energy. Notably, the investigation uncovered that the strain rate exerts a considerable influence on the compressive characteristics of both traditional and cable fibre-reinforced concrete. A trend was identified wherein enhancements in ultimate stress, energy absorption at ultimate strength, and fracture energy were observed associated with increasing strain rates. In contrast, the strain at ultimate strength exhibited a decline under these conditions. This pattern underscores the key role of fibre inclusion in enhancing specific mechanical properties while concurrently mitigating the propagation of cracks. The integration of a 10 % fibre volume fraction enhances the dynamic compressive properties of the material, making it more adept for applications in pavement. Such findings underscore the potential of fibre-enriched concrete, particularly with the addition of communication cable waste, as a robust alternative in the construction of pavements, where dynamic load-bearing capacity is essential.

Keywords: Communication Cable Waste; Cable Fibre-concrete; Compressive Responses; Varying Loads

ICSBE24_295

COMPARISON OF PHYSICAL AND MECHANICAL PROPERTIES OF FLY ASH BRICKS WITH NORMAL CLAY BRICKS

U.G.R.P.C. Kumara, Chandana Kulasuriya*
Department of Civil Engineering, Faculty of Engineering Technology,
The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka
**Correspondence E-mail: ckula@ou.ac.lk, TP: +94703593312*

Abstract: This research compares the physical and mechanical properties of fly ash bricks with traditional clay bricks. Traditional bricks are made by burning blocks made of clay. Manufacturing fly ash brick involves elevated temperature curing of blocks made of a mixture constituting fly ash, lime, and sand. The quality and properties of the bricks were assessed through tests for compressive strength, water absorption, and efflorescence. Fly ash bricks with different mix proportions were tested, and the mix comprising 15 % fly ash, 35 % lime, and 50 % sand exhibited the highest compressive strength, which is 5.04 MPa. The compressive strength of conventional clay bricks varies by location, with an average value of 4.81 MPa. The physical properties, including weight, density, and water absorption, were also determined and compared to traditional bricks. The average density of clay bricks was calculated as 1747 kg/m³, with water absorption rates specified for different grades. The mixture comprising 15 % fly ash, 35 % lime, and 50 % sand demonstrated the lowest water absorption rate at 8.4 % and a density of 2001 kg/m³. The findings suggest that bricks containing fly ash, lime, and sand could serve as viable construction materials, with a surface colour resembling cement bricks, potentially reducing plastering costs. Finally, based on the findings, the paper suggests recommendations for future research.

Keywords: Fly Ash; Lime; Sand; Compressive Strength; Water Absorption; Steam Curing

ICSBE24_180

DEVELOPMENT OF COIR FIBER REINFORCED CEILING BOARD WITH INTEGRATED MECHANICAL, THERMAL, AND PHYSICAL PROPERTIES

D.A. Madarasinghe[1*], Kumari Gamage[2], E.R.K. Chandrathilake[1], N.W.A. Lidula[1], A.A.P. De Alwis[1]

[1]University of Moratuwa, Katubedda, Sri Lanka
[2]Engineering Institute of Technology, 333 Adelaide Street, QLD4000, Australia
**Correspondence E-mail: damadarasinghe@gmail.com, TP: +94777218714*

Abstract: Controlling heat gains in buildings is a key focus area which should be addressed to reach sustainable thermal comfort and energy savings in buildings. About 75 % of the thermal energy incidents on a building envelope travel via the roof. Accommodating low conductive ceiling sheets can control the heat transfer in the building resulting in improved thermal comfort with a significant energy saving. However, utilization of waste materials in the fabrication of ceiling sheets is a timely need. This paper presents an innovative approach of developing a roofing sheet using waste materials, including Polyethylene terephthalate plastic ((PET) water bottles), Extruded Polystyrene Foam (EFF), waste polythene (Low-density polyethylene (LDPE)) and coconut coir fibers. Three distinct binding materials were combined in six different mix ratios to create a total of eighteen types of sheets. The Scanning Electron Microscopy (SEM) images reveal that the samples containing coir fiber and LDPE exhibit a homogeneous layer and also the measured properties indicated low void ratio with enhanced dry density and reduced water absorption in developed sheets. This study showed the possibilities of producing ceiling boards with coir fiber and LDPE with excellent mechanical, thermal and durability performance.

Keywords: Sustainability; Waste Materials; Ceiling Boards; Heat Transfer; Thermal Comfort

ICSBE24_126

EFFECT OF SAND TYPES ON MECHANICAL PERFORMANCE AND MORPHOLOGY OF CEMENT MORTAR COMPOSITE CONTAINING CEMENT STRENGTH CLASS 42.5 N

A.M.B. Chandima[1*], D.D. Dheerarathna[2], S. Guluwita[3], M.T.K.P. Perera[2]
[1]Wayne State University, Detroit, MI 48202, USA
[2]SCOT Campus, Department of Civil Engineering, Nugegoda, Sri Lanka
[3]University of Moratuwa, Department of Materials Science and Engineering, Sri Lanka
**Correspondence E-mail: hk9556@wayne.edu, TP: +13134341644*

Abstract: Concrete and cement mortar is the most common cement-based composite used in the construction industry. Cement mortar, a composite of cement, sand, and water, is used in various aspects of civil engineering, namely, masonry, brickwork, plastering, flooring, etc. This research paper aims to provide a detailed investigation of the effect of types of sand on the hardening properties and morphology of Ordinary Portland Cement (OPC) mortar and Portland Fly ash Cement (PFC) mortar. The construction industries are exploring effective and low-cost microfillers that improve the properties of concrete structures. During this research, three types of sand, ISO Standard sand, river sand, manufactured sand, and micro silica, were used with cement mortar. ISO standard sand is natural sand, which is siliceous, particularly its finest fractions, and they are isometric and rounded in shape. Even though the same particle size distribution of R-sand and Manufatured Sand revealed a decrease in the compressive strength of 13.8 % and 24.2 % of OPC mortar, respectively, for 150 days. It was a 17 % and 24 % reduction in PFC mortar. While adding ultra-fine particles and removing deleterious fines enhanced the compressive strength of the cement mortar. The maximum increase in compressive strength was achieved by replacing 15 % of sand from micro-silica, 13 % and 11 %, concerning the reference cement mortar of OPC and PFC samples, respectively. Further research was done to obtain a cost-effective product by replacing 10 % of cement with micro silica. It has been revealed that there were 10 % and 09 % enhancement of compressive strength in OPC and PFC samples, respectively, for 150 days. Morphology analysis and the packing density of the cement mortar samples revealed that fines act as inert mineral fillers and enhance the structure of the cement matrix.

Keywords: Manufatured Sand; River Sand; Micro Filler; Compressive Strength; Packing Density; Morphology

ICSBE24_069

EVALUATING THE CRACKING BEHAVIOR OF RECYCLED TILE WASTE AGGREGATE CONCRETE

P.U.D. Pathirana*, U.N.D. Perera, R.S. Mallawaarachchi
Department of Civil Engineering, Sri Lanka Technological Campus, Padukka, Sri Lanka
**Correspondence E-mail: upekshapathirana995@gmail.com, TP: +94703098987*

Abstract: The use of recycled ceramic tile waste in concrete has gained widespread attention due to pressing concerns about the scarcity of natural resources and the management of construction and demolition waste. It contributes to the development of eco-friendly construction practices while attempting to reduce the environmental impact associated with tile disposal. This research primarily focuses on investigating the impact of replacing coarse aggregates in concrete with Recycled Tile Waste Aggregates (RTWA) on cracking behavior, an area that has not received much attention in previous research. A comparative study was conducted between beams with natural aggregates and RTW aggregates, specifically targeting the identified optimal replacement ratio of 20 %. Three-point bending tests were carried out to systematically investigate crack formation, propagation, and failure mechanisms, providing insights into the material's flexural performance. In conjunction with evaluating the crack patterns, compressive strength tests were carried out on cube specimens to gain an understanding of the material's mechanical strength properties. The study reveals that the RTWA-replaced beam exhibits a lower incidence of cracks compared to the beam with natural aggregates. According to the results obtained, RTW concrete showed a 26 % higher compressive strength than natural aggregate concrete and a 4.2 % decrease in flexural strength performance. The findings of this research project offer the possibility of effectively integrating recycled tile waste aggregates into concrete production.

Keywords: Recycled Tile Waste Aggregates; Concrete Cracking Behavior; Eco-friendly Construction; Compressive Strength; Flexural Performance

ICSBE24_141

A REVIEW OF ENHANCEMENT OF STRUCTURAL PROPERTIES OF CEMENTITIOUS MATERIALS VIA GRAPHENE OXIDE

W.S.P. Peiris*, C.J. Thambiliyagodage, S.V.T.J. Perera, R.K.N.D. Rajapakse
Sri Lanka Institute of Information Technology (SLIIT), Malabe, Sri Lanka
**Correspondence E-mail: sathya.p@sliit.lk, TP: +94770825298*

Abstract: Cement-based composites are the most durable and widely used construction materials due to their low cost and longevity. However, factors such as carbonation, fire, freeze-thaw cycles, chemical attacks, leaching, and fatigue crack propagation can significantly affect durability and reduce the lifespan of concrete structures. Recently, Graphene Oxide (GO) has gained considerable attention for its potential to enhance the durability and mechanical properties of cementitious materials. Past research papers show that incorporating Graphene Oxide (GO) into cement-based composites significantly improves durability due to its unique atomic lattice structure. This review examines recent research on how GO enhances the durability characteristics of cement composites, with a particular focus on the effects of ageing. The review pulls together findings from various studies to explore how GO impacts key durability factors such as mechanical strength, sorptivity, and thermal and shock resistance. GO's nanoscale reinforcement enhances mechanical strength by increasing the material's load-bearing capacity and resistance to cracking. The reduction in sorptivity indicates that these composites are less susceptible to water penetration, thereby enhancing their long-term durability. GO enhances thermal and shock resistance, making the composites more resilient in extreme conditions. Microstructural analysis reveals a denser, less porous matrix, which enhances overall durability. Additionally, GO helps reduce creep deformation, crucial for maintaining the material's structural integrity over time. However, this review also highlights challenges, such as difficulties in uniformly dispersing GO within the cement matrix and concerns about long-term degradation under various environmental conditions. The impact of ageing on durability is critically examined, highlighting areas where more research is needed to optimize GO-reinforced cementitious materials fully. The review concludes by addressing the challenges and limitations of graphene oxide in construction, providing valuable insights for future research.

Keywords: Graphene Oxide; Durability; Compressive Strength; Sorptivity; Ageing

ICSBE24_177

TEMPERATURE ASSESSMENT OF CONCRETE MADE UP OF RECYCLED WASTE PLASTIC

C. Nirushan*, G. Nantharuban, T. Abirami, C.S. Bandara
Department of Civil Engineering, University of Peradeniya, 20400, Sri Lanka
**Correspondence E-mail: niruchan176@gmail.com, TP: +94773531705*

Abstract: Plastic waste is an ever-growing environmental issue, with millions of tons of plastics ending up in dumpsites and oceans. Recycling plastic waste and utilizing it as a concrete constituent provides a sustainable solution for plastic waste management. Further, it lessens the reliance on natural resources to produce concrete. Several studies have been carried out to determine the mechanical & durability properties of concrete with recycled polypropylene (PP) plastic waste aggregates. The present study attempted to examine the potential of partially replacing PP as a coarse aggregate in High-Strength Concrete (HSC) to produce Medium-Strength Concrete (MSC) and to study the behavior of concrete with PP subject to elevated temperatures. The experimental program contained two series of concrete batches: one with 20 % PP plastic and the other without PP plastic (traditional concrete), with a water/cement (w/c) ratio of 0.32. The compressive strength and the splitting tensile strength of concrete were evaluated at room temperature and 300 °C temperature. The room temperature tests showed that the compressive strength of concrete without plastic aggregate was about 73 MPa (hence HSC), and the compressive strength of concrete with plastic aggregate was about 55 MPa (hence MSC). The compressive strength of HSC and MSC reduced considerably as they were subjected to high-temperature levels, with specimens having PP content experiencing a greater compressive strength reduction of about 42 % compared to traditional HSC concrete tested at room temperature. Under room temperature and elevated temperature, adding 20 % of PP reduced the splitting tensile strength by 36 % and 19 %, respectively compared to traditional concrete.

Keywords: Recycled Plastic Waste; Workability; Compressive Strength; Splitting Tensile Strength, Elevated Temperature

ICSBE24_038

INVESTIGATION OF THE SUITABILITY OF THE SANDY SOIL AVAILABLE IN BALANGODA - KODDUWATHTHA AREA FOR USE AS FINE AGGREGATE

H.C.D. Obeysekara, A.M.N. Alagiyawanna, R.A.N. Dilrukshi*
Department of Construction Technology, Faculty of Technology,
Wayamba University of Sri Lanka, Lionel Jayathilake Mawatha,
Kanadulla, Kuliyapitiya, Sri Lanka
**Correspondence E-mail: dilrukshi@wyb.ac.lk, TP: +94716434803*

Abstract: As a solution for the scarcity of Natural Fine Aggregate (NFA) for constructions, this study aimed to investigate the suitability of a Sandy Soil (SS) available in Balangoda - Kodduwaththa area in Sri Lanka as a fine aggregate for casting paving blocks. Initially, the control samples of paving blocks with dimensions of 200 mm × 100 mm × 60 mm were cast using NFA to determine the compressive strength and Water Absorption (WA). Subsequent paving blocks were cast by adding NFA with the SS at different percentages such as 10 %, 25 %, 50 %, 75 %, and 100 % and cured in water for 7 and 28 days to observe the variation in the compressive strength. All paving blocks were cast under DOX mix design proportions. Further, the WA test was conducted for a separate set of paving blocks prepared by adding NFA with SS for the same percentages mentioned above. The results showed that the compressive strength decreased with the increase of the added percentage of SS. Paving blocks cast with 100 % replacement of NFA with the SS showed compressive strength values that satisfied for the Strength class 4 in SLS 1425 Part 1: 2011. The WA of the blocks with 100 % replacement of NFA with the SS were 7.38 %. It was more than the specification limits given in SLS 1425 Part 1: 2011 for strength class 1, 2 and 3. However, there isn't any specified limit given for strength class 4 which is used for pedestrian use. Therefore, there is a possibility to use the paving blocks made by 100 % replacement of NFA with the SS for pedestrian use excluding any vehicle access by confirming the suitability of the SS available in Balangoda - Kodduwaththa area as a substitute for NFA for the production of concrete paving blocks, particularly for Pedestrian use.

Keywords: Sandy Soil; Natural Fine Aggregate; Paving Blocks; Compressive Strength; Water Absorption

ICSBE24_666

BIOPHILIC DESIGN IN MEDICAL FACILITIES: ENHANCING PATIENT RECOVERY AND WELL-BEING THROUGH SUSTAINABLE ARCHITECTURE

P.M.J.S. Karasnagoda[1*], O.K.C. Rankothge[2], B.H. Pathirana[2], S.A.G.L. Gunawardhana[2]

[1]Faculty of Biomedical Engineering,International College of Business and Technology, Srilanka
[2]Faculty of Electrical and Electronic Engineering,
International College of Business and Technology, Srilanka
**Correspondence E-mail: jananisanjula7@gmail.com, TP: +94707067448*

Abstract: The healthcare industry is increasingly recognizing the importance of creating healing environments that contribute to patient recovery and overall well-being. Biophilic design, which integrates natural elements into built environments, offers a promising approach to achieving this goal. This research investigates the application of biophilic design principles in medical facilities, focusing on how sustainable architecture can improve patient outcomes and staff well-being. The study explores various biophilic elements, such as green walls, natural lighting, indoor gardens, and the use of sustainable materials, to assess their impact on patient recovery rates, stress reduction, and mental health. Additionally, the research examines how these elements contribute to energy efficiency, indoor air quality, and the reduction of the facility's carbon footprint. Through a combination of case studies, patient surveys, and environmental monitoring, the research aims to quantify the benefits of biophilic design in medical settings. The findings are expected to provide valuable insights for architects, healthcare providers, and policymakers, encouraging the adoption of sustainable design practices in the construction and renovation of medical facilities. Ultimately, this study seeks to demonstrate that biophilic design not only enhances patient and staff experiences but also aligns with broader sustainability goals, contributing to the overall efficiency and resilience of healthcare infrastructure.

Keywords: Biophilic Design; Sustainable Architecture; Patient Recovery; Healthcare Facilities; Indoor Gardens; Energy Efficiency

ICSBE24_256

DRUG-LOADED MESOPOROUS SILICA NANOPARTICLES DERIVED FROM RICE HUSK FOR ANTI-BACTERIAL WOUND FORMULATIONS

S. Dharshika[1], D.C. Manatunga[1, 2, 3*], M.M.M.G. Prasanga Gayanath Mantilaka[4], V.G.C. Samanmali[4, 5]

[1]Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Homagama 10206, Sri Lanka
[2]UCL School of Pharmacy, 29-39 Brunswick Square, London WC1N 1AX, United Kingdom
[3]CAMD Research Laboratory, Department of Chemistry, University of Colombo, Colombo 00300
[4]CodeGen International (Pvt) Ltd., Nanotechnology and Science Park, Mahenwatte, Pitipana, Homagama 10200, Sri Lanka
[5]Faculty of Graduate Studies, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka
**Correspondence E-mail: danushi@sjp.ac.lk, TP: +94774534192*

Abstract: Fusidic Acid (FA) loaded Mesoporous Silica Nanoparticles (MSNs) with antibacterial activity is an ideal model for topical burn injuries. Especially, rice husk derived mesoporous silica nanoparticles are biocompatible, non-toxic and stable which are beneficial for topical administration. The present study aims to optimize both MSNs and FA loaded MSNs for wound care with minimal concentration and prolonged drug half-life. The MSNs were fabricated using sol-gel method, whilst FA was incorporated into MSNs by diffusion in ethanol mixture. The fabricated materials were characterized by SEM, FT-IR, XRD and TGA. The MSNs showed 57 % yield from rice husk ash and XRD patterns revealed an amorphous nature of MSNs. An Encapsulation Efficiency (EE), of 67.06 ± 1.18 % was resulted, whereas about 98 % of FA was released at 48 h ensuring sustained release. The antibacterial activity confirmed the highest antibacterial properties of 5 % (w/w) FA incorporated MSNs as of 25.3 ± 0.2 mm against only gram-positive, *Staphylococcus aureus* bacteria. In conclusion, the results of the present study ensure that rice husk derived MSNs as a nanocarrier for FA, along with the sustained antibacterial activity, make it beneficial for wound healing that could be an alternative to commercial formulations.

Keywords: Diffusion; Fusidic Acid; Sol-gel; Topical Administration; Wound Healing

ICSBE24_257

ENHANCING CADMIUM ION ADSORPTION CAPACITY USING HIGH-PERFORMANCE GRAPHENE OXIDE-COATED BANANA FIBERS

H.M.S.S. Samarajeewa[1*], D.C. Manatunga[1], M.M.M.G.P.G. Mantilaka[2]
[1]Department of Biosystems Technology, Faculty of Technology,
University of Sri Jayewardenepura, Homagama 10206, Sri Lanka
[2]Scientific Research and Innovation, CodeGen International (Pvt) Ltd,
Trace Expert City, Colombo 10, 01000, Sri Lanka
**Correspondence E-mail: saumyasadeepa@gmail.com, TP: +94727043810*

Abstract: Urbanization and industrialization have led to an increase in environmental wastewater, and traditional treatment methods are insufficient due to high costs and low efficiency. This necessitates the development of new techniques for treating industrial wastewater. Cadmium is a known cancer-causing agent and is linked to environmental health issues. Many studies focus on reducing the presence of heavy metals in the environment. This study explores using Graphene Oxide-coated banana fibers as a nanomaterial to adsorb Cadmium ions from wastewater. Graphene Oxide (GO) was synthesized using Modified Hummers' method with a 24-hour oxidation time and characterized using X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectroscopy (FTIR), and Raman spectroscopy. The XRD pattern of GO revealed a narrow peak at 11.44°, corresponding to the (001) reflection plane. The FTIR spectrum of GO shows a broad peak at 3410 cm^{1-}, which is associated with O-H bond stretching, revealing hydroxyl groups. The 1724 cm^{1-} band indicates carboxyl groups, while the 1618 cm^{1-} peak is attributed to the OH groups of water molecules adsorbed on GO. The peaks at 1374 cm^{1-} and 1216 cm^{1-} correspond to the C-OH group and C-O-C stretching, respectively. The Raman spectrum of GO shows a disorder-induced peak (D band) at 1350 cm^{1-} and an intense tangential mode (G band) at 1590 cm^{1-}. SEM images of synthesis GO reveal a wavy, folded shape and thin layers. The Cadmium ion removal process was studied using GO-coated banana fibers in laboratory-scale batch adsorption experiments. The effects of various parameters, including pH, concentration, and time, on adsorption were analyzed using kinetic models. The study revealed that banana fibers coated with 2 wt % GO effectively removed 98.02 % of Cadmium ions at pH 5 within 10 minutes for a 400 ppm concentration Cadmium ion solution. The adsorption process followed the pseudo-second-order kinetic model, indicating its effectiveness in Cadmium ion removal.

Keywords: Adsorption; Cadmium; Graphene Oxide; Wastewater

ICSBE24_255

ANTIBACTERIAL AND ANTIFUNGAL EFFECT OF ARROW ROOT - ZINC OXIDE NANOCOMPOSITE

R.G.B.M. Ranatunga[1*], K.C.U. Perera[2], O.K.D.U.P. Nishshanka[3]
[1]College of Chemical Sciences, Institute of Chemistry Ceylon, Rajagiriya, Sri Lanka
[2]University at Buffalo, New York, USA
[3]The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka
**Correspondence E-mail: binuranatunga98@gmail.com, TP: +94764872478*

Abstract: Arrowroot is a valuable source of unconventional starch with proven therapeutic effects including antibacterial and antifungal effects. Zinc Oxide Nanoparticles (ZnO NPs) are also known to have outstanding antibacterial and antifungal properties. But currently available research findings do not reveal any data on the possible synergistic enhancement of antibacterial and antifungal effects of the Arrowroot – ZnO nanocomposite compared to their individual counterparts. The aim of this research is to address that gap in scientific literature. Arrowroot powder is obtained from the rhizomes of *Maranta arundinacea* (*Hulankeeriya*), ZnO NPs are synthesized using sol gel chemical synthesis method and characterized using UV-visible spectroscopy, Fourier transform infrared spectroscopy and Scanning electron microscopy. Separate concentration series of the obtained Arrowroot powder, synthesized ZnO NPs and Arrowroot - ZnO nanocomposite produced by mixing Arrowroot powder and synthesized ZnO NPs in 1:1 volume ratio and incubating for 2 hours are used as test solutions. Antibacterial assay is conducted using Gram positive *Staphylococcus aureus,* Gram negative *Escherichia coli* and *Pseudomonas aeruginosa* and antifungal assay is conducted using *Candida albicans* as test pathogens. Significant antibacterial and antifungal activities were observed against the test pathogens for the synthesized ZnO NPs which increased with the increasing concentration of nanoparticles. There was no antibacterial or antifungal activity observed against any of the Arrowroot concentrations including higher concentrations. Interestingly, an increased antibacterial activity against Gram negative bacteria and antifungal activity were resulted from the combination, compared to their individual counterparts. Also, this increment was higher at low concentrations of ZnO NPs present in the composite than when it is present in higher concentrations. In the future, these Arrowroot - ZnO nanocomposites have the potential to be used in the field of medicine for developing new drugs with fewer side effects as a promising solution for the global threat of antibiotic resistance.

Keywords: Arrowroot; ZnO Nanoparticles; Arrowroot-ZnO Nanocomposite; Antibacterial; Antifungal

ICSBE24_318

NANOTECHNOLOGY-ENHANCED CRISPR-CAS9 EPIGENOME EDITING FOR CANCER THERAPY: INNOVATIONS IN DELIVERY, TARGETING AND SAFETY

W.G. Dinushi*
Department of Molecular Biology & Biotechnology, Faculty of Science, University of Peradeniya, 20400, Sri Lanka.
**Correspondence E-mail: dinushigamage96@gmail.com, TP: +94763492097*

Abstract: Epigenome editing with CRISPR-Cas9 has emerged as a viable strategy for targeted cancer therapy due to the potential for precise modifications of epigenetic markers that control gene expression in cancer cells. However, its clinical applicability is limited by issues such as probable systemic toxicity, low delivery efficiency and off-target effects. Although CRISPR-Cas9 mediated epigenome editing has great promise for cancer therapy, nanotechnology has not been fully integrated to further enhance safety and optimize delivery. The major objective of this review is to address this gap, a variety of nanotechnology-based delivery systems are evaluated along with their role in enhancing precise targeting and enhancing safety. A review of studies published between 2014 and 2024 on nanotechnology-based delivery systems and epigenome editing was conducted using peer-reviewed articles from Nature, PubMed, and Scopus. Cationic and ionizable LNPs effectively deliver CRISPR-Cas9 to breast cancer cells, boosting targeted epigenetic changes while minimizing systemic toxicity. PLGA nanoparticles coated with tumour-targeting ligands improve epigenome editing in glioblastoma cells, while PEGylation increases circulation time and decreases immunogenicity, making them appropriate for in vivo applications. Gold nanoparticles functionalized with particular ligands can deliver CRISPR-Cas9 to cancer cells, improving epigenetic silencing and gene editing, and have shown promise in photothermal therapy for ovarian cancer. Metal-organic frameworks (MOFs) with surface modifications such as PEI or PEG facilitate effective intracellular transport and endosomal escape of CRISPR-Cas9. RNP-loaded MOFs achieve high gene editing capacity and epigenetic modifications in colorectal cancer models. Magnetic nanoparticles coated with biocompatible materials improve targeting precision, reduce systemic exposure, and enable specific epigenome editing of tumour suppressor genes, thereby enhancing therapeutic outcomes. The delivery of CRISPR-Cas9 for epigenome editing improved by nanotechnology enhances the precision, efficacy, and safety of cancer therapy. Future research should improve the nanoparticle designs and combine nanotechnology-based biosensors with CRISPR-Cas9 systems for personalized cancer treatment.

Keywords: CRISPR-Cas9; Epigenome Editing; Gold Nanoparticles; Lipid Nanoparticles; Targeted Delivery; Tumor Suppressor Reactivation

ICSBE24_601

PHYSIOCHEMICAL, THERMAL, AND ANTIMICROBIAL PROPERTIES OF CHITIN NANOFIBER-BASED FORMULATIONS FOR DERMAL APPLICATIONS

N.L. Rathnasinghe[1,2], B.P.S. Rajapakshe[1,2], R.A. Jayasinghe[3], A.H.L.R. Nilmini[1], N. D. Tissera[4], R. N. Wijesena[4], G. Priyadarshana[1*]

[1]Department of Materials and Mechanical Technology, Faculty of Technology, University of Sri Jayewardenepura, Pitipana, Homagama, 10200, Sri Lanka
[2]Faculty of Graduate Studies, University of Sri Jayewardenepura, 10250, Sri Lanka
[3]Department of Civil and Environmental Technology, Faculty of Technology, University of Sri Jayewardenepura, Pitipana, Homagama, 10200, Sri Lanka
[4]Department of Textile and Clothing Engineering, Institute of Technology, University of Moratuwa, Diyagama, Homagama, 10200, Sri Lanka
**Correspondence E-mail: gayanp@sjp.ac.lk, TP: +94713287738*

Abstract: Chitin nanofibers are emerging as promising biodegradable materials in various applications. Skin-invasive techniques are usually used to achieve the important goal of enhancing skin rigidity, especially in older persons. The present study focuses on the physicochemical, thermal, and microbiological properties of chitin nanofiber-based formulations containing PVA, glycerol, and cyclopentasiloxane for dermal application to increase skin rigidity rapidly. FT-IR study reveals distinctive wavelengths associated with the aliphatic O-H, NH stretching, and carbonyl groups from the acetamide group in chitin nanofibers. These spectrum characteristics confirm the presence of functional chemical groups in chitin nanofiber structures, demonstrating their molecular composition and structural integrity throughout all developed formulations. Thermogravimetric analysis showed the highest mass loss at two distinct temperature ranges (200-300 °C and 300-500 °C) as the temperature increases, indicating the intrinsic thermal resistance of chitin nanofiber-based formulations. Furthermore, the study demonstrates that chitin nanofibers have promising antimicrobial properties against various microorganisms, including *E. coli, S. aureus, P. aeruginosa*, and *K. pneumonia*. The high antimicrobial properties reported show that chitin nanofibers could be an antimicrobial agent against these prevalent infections. These results emphasize the potential of chitin-based formulations containing PVA, glycerol, and cyclopentasiloxane as a breakthrough in non-invasive dermal treatments for increased skin rigidity. The stability, efficacy, and safety of these compositions render them acceptable for incorporation into cosmetic products, offering a viable alternative to traditional skin-invasive procedures.

Keywords: Chitin Nanofiber; Dermal Application; Formulation; Properties

ICSBE24_014

WATER HYACINTH (E*ichhornia crassipes*) AS AN AQUATIC CELLULOSE NANOFIBER SOURCE; EXTRACTION, UTILIZATION AND THE SUSTAINABILITY: A REVIEW

B.P.S. Rajapakshe[1,2], N.L. Rathnasinghe[1,2], R.A. Jayasinghe[3], A.H.L.R. Nilmini[1], V. Karunaratne[4], R.N. Wijesena[5], G. Priyadarshana[1*]

[1]Department of Materials & Mechanical Technology, Faculty of Technology, University of Sri Jayewardenepura, Homagama 10200, Sri Lanka
[2]Faculty of Graduate Studies, University of Sri Jayewardenepura, Gangodawila, Nugegoda 10250, Sri Lanka
[3]Centre for Sustainable Development Reform, University of New South Wales, Sydney, Australia
[4]Sri Lanka Technological Campus, Padukka 10500, Sri Lanka
[5]Department of Textile and Clothing Engineering, Institute of Technology, University of Moratuwa, Diyagama, Homagama 10200, Sri Lanka
**Correspondence E-mail: gayanp@sjp.ac.lk, TP: +94713287738*

Abstract: Water hyacinth (*Eichhornia crassipes*), an invasive aquatic plant known for its rapid proliferation and detrimental ecological impacts, provides an excellent source of cellulose nanofibers (CNFs), containing 43- 65 % cellulose, 13-29 % hemicellulose, and 7- 10 % lignin in its composition. This review explores the extraction techniques, potential applications, and sustainability aspects of water hyacinth-derived CNFs. The extraction process involves different steps, including pre-treatment, chemical processing, and mechanical disintegration. Initially, the plant material is cleaned and dried to remove impurities and moisture prior to the chemical treatments. The chemical treatments eliminate non-cellulosic matter, and the bleaching step isolates the cellulose fibers from the biomass. To produce CNFs, high-pressure homogenization, ultrasonication, or grinding techniques are followed. The morphology, chemical composition, crystalline structure, and thermal stability of the CNFs are characterized by means of scanning electron microscopy (SEM), fourier-transform infrared spectroscopy (FTIR), x-ray diffraction (XRD), and thermogravimetric analysis (TGA) respectively. Water hyacinth-derived CNFs are employed in a wide range of biomedical applications, including medication delivery systems, wound dressings, water purification membranes, and biocomposites. Further, it is used to strengthen paper and packaging materials, improving their barrier properties. The enhanced mechanical characteristics, biodegradability, and biocompatibility of CNFs contribute to such applications. Utilizing water hyacinth minimizes its impact on the environment and transforms a problematic waste into a useful resource, which is significant from the perspective of sustainability. Additionally, eco-friendly extraction techniques reduce the amount of energy and chemicals required. The large-scale manufacture of CNFs from water hyacinth can be profitable and contribute to the circular economy by creating products that are in demand. The sustainable extraction and use of CNFs from water hyacinth not only addresses environmental issues but also possesses an immense opportunity for novel material applications that will contribute to both economic viability and environmental sustainability. Expansion of applications and process optimization require further research and development.

Keywords: Water Hyacinth; CNFs; Extraction; Utilization; Sustainability

ICSBE24_317

GREEN SYNTHESIS OF SILVER NANOPARTICLES USING FIVE VARIETIES OF *Ipomoea batatas* LEAVES AND ASSESSING THEIR ANTIOXIDANT AND ANTIMICROBIAL PROPERTIES

M.N. Herath, M. Kandiah*
School of Science, BMS, 591, Galle Road Colombo 06, Sri Lanka
**Correspondence E-mail: mathi@bms.ac.lk, TP: +94766689353*

Abstract: Silver nanoparticles (AgNPs) are one of the most commercially used nanomaterials having applications in products such as photonic devices, sensors, antimicrobial coatings, cosmetics, electronics, medical devices, water purifiers, molecular diagnostics, and, textiles. Usually, there are two approaches involved in AgNP synthesis accomplished by physical and chemical means. These techniques are expensive and sometimes even dangerous. Consequently, biological methods are preferred as they are cost-effective, eco-friendly, simple, and do not utilize toxic chemicals. Green synthesis of AgNPs is an emerging technique carried out by using different sources like bacteria, algae, fungi, and plants. As microorganisms pose the risk of contamination and lengthy procedures, plants are preferred. In this study, five varieties of *Ipomoea batatas* leaves were used to synthesize AgNPs. The five varieties Chitra, Dawala, CARI-09, CARI-426, and Wariyapola-White were collected from Peradeniya. *Ipomoea batatas* commonly known as sweet potatoes are generally planted for their tubers. Throughout harvesting, 95-98 % of the leaves are disposed of while the surplus 2-5 % is employed as animal feeds. The discarded leaves can be a promising source of natural antioxidants. Upon the addition of $AgNO_3$ solution to Leaf Extract (LE), pure Ag(I) ions reduce to Ag(0) in the presence of antioxidants. Total Antioxidant Capacity (TAC), Total Phenolic Content (TPC), and Total Flavonoid Content (TFC) of the synthesized AgNPs and their LEs were analyzed along with its antimicrobial detection. The synthesized AgNPs demonstrated a greater TPC and TAC, and lower TFC relative to their LEs. Furthermore, the biosynthesized AgNPs expressed a notable antimicrobial activity against *Staphylococcus aureus* and *Escherichia Coli,* where a higher activity was observed against gram-positive bacteria. Given the simplicity and non-toxic effects of synthesizing the AgNPs, it can be used for several applications to solve conventional problems that exist in the everyday world.

Keywords: *Ipomoea batatas*; Anti-microbial; Biosynthesis; Silver Nanoparticles; Antioxidant

ICSBE24_251

ACHIEVING STABLE AQUEOUS DISPERSIONS OF HYDROPHOBIC CARBON-BASED MATERIALS USING SURFACTANTS AND DISPERSING AGENTS

A.D.L. Attigala[1*], J.A.K. Pramod[2], D.C. Manatunga[1], N.D. Silva[2]
[1]Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Pitipana
[2]Sri Lanka Institute of Nanotechnology, Pitipana
**Correspondence E-mail: danushikalakmali90@gmail.com, TP: +94776504163*

Abstract: The hydrophobic nature of carbon-based materials like graphite and reduced graphene oxide (rGO) presents challenges in preparing stable aqueous dispersions. This study explores the use of various surfactants and dispersing agents to achieve homogeneous dispersions of these materials in water. Three surfactants - Cetyl Trimethyl Ammonium Bromide (CTAB, cationic), Sodium Laureth Sulfate (SLS, anionic), and Triton X-100 (nonionic) - were investigated based on their polar head charges. Additionally, dispersing agents widely used in industrial applications, such as polyethylene glycol (PEG), Tamol, and polyvinyl alcohol (PVA), were also tested. Graphite dispersions were examined using pure PEG, PVA, and combinations like PEG-PVA, PEG-Tamol, PEG-SLS, and SLS-PVA, while rGO dispersions were evaluated with CTAB, PVA, Triton X-100, and PEG+TEOA mixed surfactants. Among these, PVA demonstrated superior dispersing capability for both graphite and rGO, with a highest dispersibility of 3.95 mg/mL for graphite and 1.00 mg/mL for rGO. Building on previous research, the effect of mixed surfactants on dispersion stability was studied, highlighting the ability of these blends to modulate surface charge and control attractive or repulsive forces in the dispersion medium. Characterization techniques, including zeta potential measurements, particle size analysis (PSA), and UV-Visible spectrophotometry, were employed to assess colloidal stability. This study presents a novel approach by combining mechanical probe sonication with chemical dispersion methods.

Keywords: Graphite; rGO; Probe Sonication; Mixed Surfactants

ICSBE24_252

NANOTECHNOLOGY IN PREVENTIVE HEALTHCARE: REVOLUTIONIZING DISEASE DETECTION AND SAFETY THROUGH NANO-ENABLED DIAGNOSTICS AND THERAPEUTICS

P.V.V. Ranmini*
Department of Chemistry, Faculty of Science, University of Colombo
**Correspondence E-mail: vihangaranmini1@gmail.com, TP: +94712095702*

Abstract: Nanotechnology is vital in preventive health, transforming disease detection and therapeutic strategies. This field will hopefully change the way diseases will be detected when they are at their most incipient stage, hence timely and precise intervention, which would go a long way to significantly enhance patient outcomes and overall health management. Despite significant progress in this area, the development of reliable, scalable nanotechnologies for routine clinical prevention remains underexplored. It is crucial to explores how nanotechnology is transforming preventive healthcare, focusing on its applications in disease detection and targeted therapeutics to address these challenges. A comprehensive search for studies published between 2010 and 2024 was conducted on nanorobotics, nanotheranostics, and nanoparticle-based drug delivery systems to determine their effectiveness in disease prevention and treatment. The findings have shown that, advanced nanotechnology systems include: nanorobots engineered for precision in cancer therapy; nanotheranostics directed at comprehensive disease management; and DNA-based nano-devices for controlled drug delivery. Most of these advanced nanotechnology systems have been subjected to major advances. For example, nanorobots have already shown enormous promise in targeting malignant tumors with unprecedented precision and minimal collateral damage. The use of nanotheranostics has also been applied to such sophisticated conditions as hepatocellular carcinoma and COVID-19, opening new perspectives for diagnosis and treatment alike. Furthermore, enabled by nanoparticles, drug delivery systems have achieved significant breakthroughs while overcoming various obstacles, such as the blood-brain barrier, which has considerably improved neurological disorder treatments. These enable new capabilities for diagnostics and therapeutics, setting the stage for the future of predictive and personalized medicine. In summary, nanotechnology integration in preventive healthcare marks one great leap forward in disease management and patient care. Future research will be critical to further these technologies in ensuring safety, effectiveness, and applicability within a wide range of global healthcare systems.

Keywords: Nanotechnology; Nanotheranostic; Nanoparticle; Cancer; Therapeutics; Diagnostics

ICSBE24_259

PREPARATION OF ELECTROSPUN POLY-CAPROLACTONE (PCL) FIBER MATS LOADED WITH EPIGALLOCATECHIN GALLATE (EGCG) - HALLOYSITE NANOTUBES (HNT) COMPOSITES AS A POTENTIAL WOUND DRESSING MATERIAL

B.Y.W. Wickramathunge[1], V.U. Godakanda[1], P.A. Nimal Punyasiri[2], K.M. Nalin De Silva[1], Rohini M. De Silva[1*]

[1]Center for Advanced Materials and Devices (CAMD), Department of Chemistry, Faculty of Science, University of Colombo, Sri Lanka

[2]Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB), University of Colombo, Sri Lanka

**Correspondence E-mail: rohini@chem.cmb.ac.lk, TP: +94714406263*

Abstract: EGCG has been recognized to have wound-healing properties due to its anti-microbial and antioxidant properties. However, the low stability of EGCG limits its usage. HNTs are widely used in drug delivery applications owing to their ability to provide sustained release of Active Pharmaceutical Ingredients (API). Electrospinning is a versatile fabrication method that can be used to generate API-loaded material. Therefore, in this work, EGCG entrapped within HNT have been prepared as potential wound dressing materials using the electrospinning technique. EGCG was pre-loaded to HNT using a modified vacuum-assisted method to generate EGCG-HNT. EGCG-HNT loaded PCL fibers were electrospun from a 25 % w/v PCL solution with 8 % w/v EGCG-HNT under a voltage of 19 kV, with 10 cm between the needle tip and collector, with pump rate at 1 mLh^{-1}. The control mats were generated under the same electrospinning conditions. The morphological characterization and the chemical compatibility of prepared mats and controls were carried out using SEM and FT-IR, respectively. The SEM results of control mats with PCL-HNT indicated fibers with smooth surfaces and cylindrical morphology, with most of the fiber diameters in the 1 µm range. PCL-EGCG-HNT mats exhibited areas with deformed fibers with uneven diameter distribution. The Results of the FT-IR analysis demonstrated the stability of EGCG-HNT over 90 days. The results of the *in-vitro* antibacterial assay depicted the concentration-dependent antibacterial effect of EGCG against *Staphylococcus aureus* (ATCC 25923) for neat EGCG and EGCG-HNT. EGCG-HNT was observed to give larger inhibition zones (IZ) compared to that of relevant EGCG concentrations. PCL-EGCG-HNT mats (0.5 x 0.5 cm^2) showed IZ of 0.96±0.08 cm diameter against the same bacterial strain. Results obtained for the radical scavenging test (using DPPH assay) indicated comparable antioxidant activity from PCL-EGCG-HNT (90±2 %) to that of neat EGCG (91±0 %). Thus, the novel electrospun PCL-EGCG-HNT fiber matrix developed in this work shows potential for its use as a wound dressing material due to its anti-bacterial and antioxidant activity.

Keywords: Epigallocatechin Gallate; Halloysite Nanotubes; Electrospinning; Wound Dressing; Anti-bacterial

ICSBE24_250

DEVELOPMENT OF A BIODEGRADABLE NANOCOMPOSITE MEMBRANE USING CHITOSAN AND GREEN NANOPARTICLES FOR WASTEWATER TREATMENT

G.C.C. Ginige, P.M. Manage, F.S. Idroos*
Centre for Water Quality and Algae Research, Department of Zoology,
Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka
**Correspondence E-mail: sumaiyaidroos@sci.sjp.ac.lk, TP: +94759288327*

Abstract: In the growing demand for sustainability, research on inexpensive, non-toxic, and biodegradable materials has been in the limelight. This study presents the development of a novel Chitosan/ green ZnO nanocomposite membranes for wastewater treatment. The research highlights the use of sustainable materials: chitosan extracted from shrimp shells (seafood waste) and ZnO nanoparticles synthesized through a green synthesis approach utilizing the invasive plant, *Hydrilla verticillata*. This work represents the first recorded instance of using chitosan and green-synthesized ZnO Nano Particles (NPs) from *Hydrilla verticillata* for nanocomposite production via a solution-casting method. Four types of membranes were fabricated by incorporating varying ZnO NP content (0.0, 0.2, 0.5, and 0.8 g) into a fixed amount of chitosan (1.0 g). Characterization using X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy (SEM) confirmed the successful synthesis and presence of ZnO NPs with an average crystallite size of 27.49 nm, moderately dispersed within the chitosan matrix. The wastewater treatment was evaluated for Rubber industry wastewater. Water quality parameters such as Electrical Conductivity (EC), Phosphate, Nitrate, Chemical Oxygen Demand (COD), Total water quality parameters Dissolved Solids (TDS), Cadmium (Cd), Zinc (Zn), Lead (Pb), Nickle (Ni) and Copper (Cu) were measured before and after treatment. The 1:0.8 (w/w) Chitosan:ZnO NP ratio showed the highest potency for the removal of pollutants. Over 50 % removal of pollutants, including phosphate (79.32±0.22 %), nitrate (90.71±0.39 %), COD (78.24±0.17 %), Zn (52.99±0.09 %), Pb (53.97±0.66 %), Ni (56.85±0.35 %), and Cu (79.32±0.22 %), was achieved by the optimal CS;ZnO ratio 1:0.8 (w/w) after two consecutive treatment cycles. These results indicate the potential use of these nanocomposite membranes as a promising method for wastewater treatment.

Keywords: Chitosan; Invasive Plants; Green Synthesis; Nanocomposite Membrane; Wastewater Treatment; Sustainability

ICSBE24_502

A SYSTEMATIC REVIEW OF SURFACE WATER QUALITY IN SRI LANKA: IDENTIFYING POLLUTION SOURCES, IMPACTS, AND SUSTAINABLE MANAGEMENT APPROACHES

M.A.D.K. Jayathilaka*, S. Miththiya, H.M.S. Shammika, A.H. Weerakoon, G.Y. Jayasinghe

Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Matara-Kamburupitiya Rd, 81100, Sri Lanka
**Correspondence E-mail: jayathilaka11gt@ags.ruh.ac.lk, TP: +94766875639*

Abstract: Sri Lanka faces a serious challenge of surface water pollution that directly affects the quality of environmental, social, and economic wellbeing; only 25 % of households have access to clean water. Through this systematic review, it fills an important research gap to examine all sources of surface water pollution, their cumulative ecological and health impacts, and provide sustainable management strategies for the principal water bodies in the country. Twenty English language articles published between 2000 and 2024 were selected according to PRISMA from Google Scholar and ResearchGate. Unplanned urbanization, rapid industrialization, agricultural practices, saltwater intrusion, especially the non - conformity of small and medium sized industries to national regulatory standards, are found as the main drivers of pollution. The effluents of two chromium-based leather tanning facilities along the *Kelani* River contain hazardous chromium concentrations up to 0.028 mg/L. Levels of suspended sediments, Nitrogen (N) and Phosphorus (P) are raised by agricultural practices and indiscriminate waste disposal in the lower catchment areas of the *Gin* River (Waduraba, Kahaduwa and Baddagama). Moreover, nine tributaries of the *Mahaweli* River's upper catchment have been contaminated with Cadmium (Cd) at concentrations ranging from 20 mg/L with major agricultural input, directly affecting renal failure epidemic among farmers in the North Central Province. In fighting these burning issues, this review concentrates on a couple of specifically aimed mitigation tactics – the promotion of sustainable agricultural practice, stringent effluent treatment standards and the use of constructed wetlands as a good filtering system. It calls for stricter enforcement of existing laws as a means to strengthen regulatory compliance, roles of mangrove ecosystems as natural biofilters and zoning regulations managing industrial emissions. In addition, long-term improvements will require a robust policy framework, as well as active stakeholder collaboration. Protection of Sri Lanka's surface water resources necessitates integrated, sustainable water management solutions that will improve public health outcomes across the country.

Keywords: Surface Water Quality; Pollution Sources; Agricultural Runoff; Environmental Impacts; Sustainable Mitigation Strategies; Water Quality Assessment

ICSBE24_153

FEASIBILITY OF ADVANCING BUILDING AUTOMATION SYSTEMS IN SRI LANKA: A REVIEW OF CUTTING-EDGE SOLUTIONS FOR SUSTAINABLE ENERGY MANAGEMENT

W.D.G.N. Bandara[1*], W.D.A.C. Bandara[2]
[1]Eutech Cybernetic Lanka (Pvt) Ltd, Havelock Road, Colombo 05, Sri Lanka
[2]Faculty of Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: gihaninb@gmail.com, TP: +94716858289*

Abstract: In contemporary setting, the sustainability of buildings is predominantly supported by the integration of Building Automation Systems (BAS). Incorporating cutting-edge technologies can greatly enhance BAS's operational capabilities. Global forecasts indicate that BAS leveraging cutting-edge technologies such as Internet of Things (IoT) and Artificial Intelligence (AI) have the potential to reduce energy consumption in buildings by over 30 % by 2040. While developed countries have widely adopted these advancements in buildings, their application in Sri Lanka remains under-explored. Examining the feasibility of this multidisciplinary integration presents an opportunity to address the country's escalating energy demand and frequent power deficits. Drawing on scholarly literature from 2012 to 2024, this study highlights how IoT-AI-driven BAS can tackle Sri Lanka's unique socioeconomic and environmental challenges in the construction sector, particularly in commercial buildings. A comprehensive thematic analysis is organized into several sub-fields, exploring the feasibility of IoT-AI-driven BAS for energy management through applications such as effective grid interactivity, dynamic window tinting, adaptive facades, and occupancy-based building controls. Global trends such as demand response, real-time monitoring, remote provisioning, predictive maintenance, and alignment with sustainability standards are discussed in relation to the Sri Lankan context. Inadequate infrastructure, high capital costs, and regular fluctuations of weather and outdoor conditions are identified as significant obstacles to successful implementation. Directions are centered on developing local expertise, performing detailed cost-benefit assessments, and securing foreign investment. The findings justify that IoT-AI-driven BAS have substantial potential to improve building performance and reduce Sri Lanka's energy footprint. To overcome existing obstacles, strategic investments, capacity building, supportive policies, and public-private partnerships are crucial. As nearly Zero-Energy Buildings (nZEB) gain global prominence, adopting advanced BAS technologies in Sri Lanka will be vital for optimizing building operations and achieving long-term energy efficiency.

Keywords: Building Automation System; Internet of Things; Artificial Intelligence; Energy Management; Nearly Zero-energy Buildings

ICSBE24_176

AUTOMATED GLASS CLEANING MACHINE

V.B. Sandaruwan*

Deparment of Mechanical Engineering, Faculty of Engineering, University of pearadeniya
**Correspondence E-mail: vgbhagyas@gmail.com, TP: +94702875922*

Abstract: It is an automatic cleaning machine of glass devised with the objective of trying to eliminate the very high risks and heavy operations of manual cleaning of windows in high-rise buildings. On the other hand, the system has been devised to clean vertical glass surfaces in big formats without having recourse to a lot of human intervention in dangerous conditions. It has a magnetic adherence system, DC motors for controlled movements, ultrasonic sensors for edge detection, and an Arduino-based control system, which is able to turn the robot on with movements over glass panels in a very stable and precise manner. Extensive engineering analysis was done to ensure that the robot would in fact work: calculation of magnetic force, frictional force, and the motor torque requirements. These analyses informed the choices made in balancing stability, cleaning efficiency, and mobility. Test results showed that on horizontal and inclined surfaces, the robot hangs onto the surface without any problem and cleans well. The test on verticals resulted in partial success because there is not enough motor torque against gravity. It can be assured that with higher torque motors and enhancements to power transmission systems, operation reliably on vertical surfaces would be achieved with the proposed changes. The general view may be that this could be a very good autonomous cleaning robot for maintaining glasses in skyscrapers-safety, low cost, and environmentally friendly. This way, it could reduce labor costs complementing labor, reducing risks to workers' lives, and also answer the growing demand for sustainable and automated solutions in building maintenance. This is an advancement in integrating robotics and automation into facility management, while exploring what the future might look like for maintaining urban infrastructure.

Keywords: Automated Glass Cleaning; High-rise Maintenance; Magnetic Adherence; Arduino Control; Robotic Cleaning; Building Automation

ICSBE24_351

FEASIBILITY OF ADVANCING BUILDING AUTOMATION SYSTEMS IN SRI LANKA: A REVIEW OF CUTTING-EDGE SOLUTIONS FOR SUSTAINABLE ENERGY MANAGEMENT

W.D.G.N. Bandara[1*], W.D.A.C. Bandara[2]
[1]Eutech Cybernetic Lanka (Pvt) Ltd, Havelock Road, Colombo 05, Sri Lanka
[2]Faculty of Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: gihaninb@gmail.com, TP: +94716858289*

Abstract: In contemporary setting, the sustainability of buildings is predominantly supported by the integration of Building Automation Systems (BAS). Incorporating cutting-edge technologies can greatly enhance BAS's operational capabilities. Global forecasts indicate that BAS leveraging cutting-edge technologies such as Internet of Things (IoT) and Artificial Intelligence (AI) have the potential to reduce energy consumption in buildings by over 30 % by 2040. While developed countries have widely adopted these advancements in buildings, their application in Sri Lanka remains under-explored. Examining the feasibility of this multidisciplinary integration presents an opportunity to address the country's escalating energy demand and frequent power deficits. Drawing on scholarly literature from 2012 to 2024, this study highlights how IoT-AI-driven BAS can tackle Sri Lanka's unique socioeconomic and environmental challenges in the construction sector, particularly in commercial buildings. A comprehensive thematic analysis is organized into several sub-fields, exploring the feasibility of IoT-AI-driven BAS for energy management through applications such as effective grid interactivity, dynamic window tinting, adaptive facades, and occupancy-based building controls. Global trends such as demand response, real-time monitoring, remote provisioning, predictive maintenance, and alignment with sustainability standards are discussed in relation to the Sri Lankan context. Inadequate infrastructure, high capital costs, and regular fluctuations of weather and outdoor conditions are identified as significant obstacles to successful implementation. Directions are centered on developing local expertise, performing detailed cost-benefit assessments, and securing foreign investment. The findings justify that IoT-AI-driven BAS have substantial potential to improve building performance and reduce Sri Lanka's energy footprint. To overcome existing obstacles, strategic investments, capacity building, supportive policies, and public-private partnerships are crucial. As nearly Zero-Energy Buildings (nZEB) gain global prominence, adopting advanced BAS technologies in Sri Lanka will be vital for optimizing building operations and achieving long-term energy efficiency.

Keywords: Building Automation System; Internet of Things; Artificial Intelligence; Energy Management; Nearly Zero-Energy Buildings

ICSBE24_105

INFLUENCE OF GRADATION ON SHEAR BEHAVIOR OF RAILWAY BALLAST MATERIAL

R. Tharmarajah*, M. Amalan, S.K. Navaratnarajah
Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: e17345@eng.pdn.ac.lk, TP: +94763179133*

Abstract: Railway ballast, composed of rock fill materials, plays a pivotal role in stabilizing rail track substructures worldwide, as it is subjected to moving train loads and environmental changes, causing deformation and degradation. To improve track performance and reduce maintenance costs, it is essential to investigate the shear behavior and degradation characteristics of ballast under different loading conditions. We should identify the factors affecting these variations. The gradation of ballast materials has a significant impact on their shear behavior, affecting track performance and maintenance requirements. This study investigates the influence of gradation on the shear behavior of railway ballast materials. As such, this involves laboratory testing of ballast samples with different gradations. Shear strength parameters are determined using Large-scale direct shear tests. The experimental study includes a range of gradations encompassing different particle sizes and distributions commonly found within and around Indian upper and lower limit gradation standards; three gradations are selected. Furthermore, a numerical model was developed to study the influence of ballast gradation and investigate the influence of vertical stress by carrying out a parametric study with different normal stresses. Shear stress increased with normal stress increment due to the improved and intensified contact between particles. A considerable increment in shear stress was obtained from the laboratory test results for gradation with a high number of larger particles. Generated numerical results showed a good acceptance with experimental results and led to carrying out a parametric study with different normal stresses. The findings of this study suggest that the presence of larger particles causes higher friction, therefore an increase in shear strength.

Keywords: Ballast Gradation; Shear Strength; Breakage; Dilation; DEM

ICSBE24_110

SHREDDED RUBBER FOR PARTIAL REPLACEMENT OF BALLAST IN RAIL TRACK APPLICATIONS

C. Thanusikan*, E. Mathynushan, S.K. Navaratnarajah
Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: kumar.sikan1997@gmail.com, TP: +94768964209*

Abstract: Railway transportation is one of the most widely used modes of transport in many countries. Ballast, the material that supports railway tracks, is crucial for providing track stability. Traditional ballast materials, such as crushed stone, gravel, and slag, are extensively utilized in railway systems due to their low initial investment and technical advantages. However, the properties of these materials deteriorate over time because of the cyclic loading of trains and environmental factors. This study inspect the use of shredded rubber as an alternative to traditional ballast material in rail track applications. Shredded rubber offers several benefits, including durability, shock absorption, noise reduction, and sustainability. The research aimed to determine the optimal percentage of shredded rubber to replace traditional ballast material by weight. Experiments were conducted using a large-scale direct shear apparatus under a normal stress of 60 kPa to measure the necessary parameters. These results were then used to calibrate and validate numerical model with the Discrete Element Method (DEM). Initially, ballast and rubber particles were collected, and a suitable ballast gradation was selected based on the standards used in Sri Lankan rail tracks. The samples were prepared by mixing shredded rubber with ballast in varying weight percentages of 0, 5, 10, 12.5, and 15 %. Subsequently large-scale direct shear tests were performed on these prepared samples. The results included a ballast breakage analysis for all tested samples, from which the Ballast Breakage Index (BBI) values were obtained. The findings indicate that increasing the rubber content in ballast mixtures reduces peak shear stress and dilation effects. Moreover, incorporating 10-15 % shredded rubber by weight can reduce ballast breakage by 52-57 %, thereby enhancing durability. The study concludes that the optimal shredded rubber content for ballast replacement is between 10-15 % by weight.

Keywords: Ballasted Track; Shredded Rubber; Discrete Element Method; Large Scale Direct Shear Test

ICSBE24_150

RECOVERED CARBON BLACK (rCB) FOR STABILIZATION OF EXPANSIVE SUBGRADE

G. Gedara*, S. Jayakody, N. Nayanthara
School of Civil & Environmental Engineering,
Queensland University of Technology (QUT), Australia
**Correspondence E-mail: gayan.gedara@hdr.qut.edu.au, TP: +61478678752*

Abstract: The problem of expansive soils is common worldwide in arid and semi-arid regions where soils are exposed to frequent extreme wet and dry seasons. Expansive soils, having a high affinity for water, easily absorb moisture, undergo significant expansion during wet seasons, and shrink during dry seasons. This cyclic shrink-swell ground movement causes considerable damage to lightweight structures. Lime stabilisation has become a globally popular approach for stabilising flexible pavement subgrades susceptible to expansive soil damage. However, with rising global concerns for sustainability and significant lime shortages, exploring the reuse of industrial byproducts and waste materials as substitutes for lime subgrade stabilisation has emerged as a significant research objective. This study evaluates the suitability of Recovered Carbon Black (rCB) for expansive subgrade treatment through a series of laboratory tests. rCB is a solid powdered residue from the pyrolysis process of End-of-Life Tyres (ELT). rCB has enabled various reuse options and provides a sustainable solution for managing the increasing tyre waste generated. To achieve the objective, rCB was mixed with soil in proportions of 5 %, 10 %, 15 %, and 20 %, and tested. Then, the results were compared to soil mixed with lime in proportions of 5 %, 10 %, and 15 %. The 1-D Oedometer-based swell test results exhibit a significant reduction in swelling with increasing rCB dosage, with near-zero swelling observed at 20 %. However, the performance is slightly lower than that of lime. Unconfined Compressive Strength (UCS) revealed that an rCB mixture achieves comparatively higher strength than pure expansive soil and performs better than lime at the exact dosage. The findings of this study demonstrate that rCB is a potential and sustainable alternative to traditional lime treatment while addressing the increasing tyre waste problem. However, as suggested by this study, further research is required to fully evaluate the feasibility and effectiveness of successful field implementations.

Keywords: Expansive Soil; Recovered Carbon Black; Sustainability; Swelling Test; Unconfined Compressive Strength; Subgrade Stabilisation

ICSBE24_151

CAPROCK INTEGRITY DURING UNDERGROUND HYDROGEN STORAGE: UNVEILING THE RISK OF CRITICAL CRACK PROPAGATION

R.A.D.P. Dilshan, M.S.A. Perera*

[1]*Department of Infrastructure Engineering, Engineering Block B, Grattan Street, The University of Melbourne, Parkville, Victoria 3010, Australia*

**Correspondence E-mail: samintha.perera@unimelb.edu.au, TP: +61390358649*

Abstract: Hydrogen is emerging as a sustainable solution to the challenges associated with traditional energy sources such as greenhouse gas emissions and climate change. It serves as a potential energy carrier to convert and store excess energy generated by renewable sources until demand rises. Comparatively, underground storage options are more viable for large-scale hydrogen storage, with depleted gas reservoirs offering significant advantages such as higher storage capacity, prior experience in gas storage, existing infrastructure, geological feasibility, and lower costs. Caprock is an impermeable layer found in these subsurface reservoirs to securely entrap injected hydrogen and prevent any upward migration into overlying strata. However, the caprock integrity is greatly affected by the high-pressure hydrogen injection, geochemical interactions within the hydrogen rock-brine system, and cyclic loading. These factors may lead to multiple crack developments in the caprock, creating new pathways for hydrogen leakage. Critical crack propagation is one of these multiple cracking mechanisms controlled by the stresses applied to the rock. High-pressure hydrogen injection poses a potential risk of caprock failure under critical crack propagation. This paper presents a systematic literature review on caprock integrity in the underground hydrogen storage context through a scientometric approach with a specific focus on critical crack propagation. The findings suggest that while significant attention has been given to geochemical interactions and hydrogen diffusion through the caprock, critical crack propagation in the caprock remains underexplored in the existing literature. Thus, this paper further proposes a suitable experimental methodology to determine critical crack propagation in the caprock during underground hydrogen storage by using rock fracture toughness as a quantitative parameter.

Keywords: Underground Hydrogen Storage; Depleted Gas Reservoirs; Caprock Integrity; Critical Crack Propagation; Fracture Toughness

ICSBE24_355

FLUID INERTIA EFFECT ON TRANSIENT FLOW THROUGH ROCK FRACTURE INTERSECTIONS: IMPLICATIONS FOR ENHANCED UNDERSTANDING AND OPTIMISATION

E.A.A.V. Edirisinghe, M.S.A. Perera*
University of Melbourne, Parkville, Victoria, Australia.
**Correspondence E-mail: samintha.perera@unimelb.edu.au, TP: +61390358649*

Abstract: Fracture flows play a pivotal role in transport phenomena in various geological and reservoir engineering applications, such as petroleum production, hydraulic fracturing for enhanced oil recovery, geothermal energy extraction, etc. The velocity of the fluid within fractures often attains a range that is intermediate to high, which promotes nonlinear flow triggered by the fluid inertia effect. However, many current studies on fluid flow in fractures rely on models that simplify or disregard the impact of fluid inertial forces. Numerical models frequently employ the Stokes equation, assuming laminar flow conditions, which can detect vortical flow patterns primarily governed by fracture geometry and remain unaffected by variations in fluid velocity. In contrast, experimental observations have shown that as the flow rate increases, eddies grow larger and occupy more space within the fractures. This effect is particularly pronounced at fracture intersections, where abrupt changes in direction and velocity can significantly enhance inertial effects. Understanding this behaviour is essential for studying flow distribution at these intersections and gaining insights into the dynamic response of fluids to variations in fracture geometry. Despite numerous experimental studies, current methodologies still fall short of providing detailed insights into the fluid dynamics at fracture intersections. This research utilises the two-dimensional particle tracking velocimetry (2D-PTV) technique to explore the influence of fluid inertia at fracture intersections within a laboratory-scale fracture intersection model, complemented by Large Eddy Simulations (LES) to generalise the experimental results. The experimental and numerical results reveal that fluid inertia significantly impacts the flow distribution and vortex dynamics across fracture intersections. Dead-ends within the fracture network significantly alter flow behaviour, leading to intensified vorticity and altered flow pathways, underscoring the importance of geometric considerations in predicting flow dynamics. Further, the first experimental results confirm that the steady flow assumption is invalid for high-velocity fracture flows.

Keywords: Fluid Inertia; Rock Fractures; Particle Tracking Velocimetry; Large-eddy Simulations; Transient Flow

ICSBE24_353

PREDICTIVE MODELLING OF MOISTURE DYNAMICS IN UNBOUND GRANULAR PAVEMENTS USING REAL-TIME SENSOR DATA AND PRECIPITATION

Ayesh Dushmantha*, P.G.N. Nayanathara, Shiran Jayakody
School of Civil and Environmental Engineering, QUT, Brisbane, Australia
**Correspondence E-mail: ayesh.gamaralalage@hdr.qut.edu.au, TP: +61414619338*

Abstract: Precipitation is the primary climatic factor affecting the moisture content of road pavements, surpassing other environmental factors. This is particularly evident in unbound granular pavements, which are significantly impacted by frequent and intense rainfall. Elevated moisture levels accelerate pavement deterioration, increasing maintenance demands and costs, with annual expenditures on road rehabilitation reaching billions of dollars. Accurate moisture prediction, based on dominant moisture-increasing climatic factor such as precipitation, is crucial for improved pavement design and maintenance. The capability to monitor moisture variation under road pavement during its operation is limited with traditional in situ testing methods. Consequently, real-time moisture measurement using embedded sensors has become popular for accurate moisture recording across different pavement layers. In this study, a road section with unbound granular pavement, prone to frequent flooding, was selected for detailed monitoring. Nine moisture sensors were installed across the pavement layers, with three sensors each in the base, subbase, and subgrade layers. These sensors recorded hourly moisture readings, while hourly precipitation was measured by a weather station installed at the site. This paper presents the development of a predictive model that incorporates precipitation and existing moisture content prior to rainfall events, rather than relying on equilibrium moisture and rainfall used in existing models. The models developed demonstrated strong performance during both the development and validation phases, achieving a Mean Absolute Percentage Error (MAPE) of less than 5 %. They are most suitable for near-surface pavement layers, rather than deeper layers such as the subgrade. The goal is to deepen the understanding of moisture behaviour in road pavements, contributing to improved design and maintenance strategies, which in turn aims to enhance the durability and performance of road infrastructure while reducing maintenance costs and improving road safety and reliability.

Keywords: Precipitation; Unbound Granular Pavement; Moisture Content; Real-time Pavement Monitoring; Prediction Model

ICSBE24_156

COMPARATIVE ANALYSIS OF RECYCLED CONCRETE AGGREGATE AND CONVENTIONAL UNBOUND GRANULAR MATERIALS USED IN LOW-VOLUME ROAD CONSTRUCTION

Ravindu Ranasinghe*, Jangchu Pelden, Ayesh Dushmantha, Shiran Jayakodi

School of Civil and Environmental Engineering,
Queensland University of Technology, QLD 4001, Australia
**Correspondence E-mail: ravindu.ranasinghe@hdr.qut.edu.au, TP: +61437205584*

Abstract: Unbound granular pavements are commonly used for low-volume roads in Queensland, Australia, with Unbound Granular Materials (UGMs) being the primary construction material, classified into five main standard material types by the Queensland Department of Transport and Main Roads (QDTMR), is the primary material used in constructing these pavements. However, the high demand for crushed rock has raised concerns about resource depletion. As a result, road agencies are increasingly exploring alternative materials, such as Recycled Concrete Aggregate (RCA), to replace conventional UGMs. RCA is currently used as a base and subbase material in pavement construction without adhering to existing standards. However, RCA must meet the performance criteria of standard UGMs to gain widespread adoption. This research evaluates RCA's geotechnical and transport-related characteristics to match the performance characteristics of high-quality Standard Material (SM01), low-quality Standard Material (SM02), or fall within this range of UGMs based on laboratory-based experiments. The study compares the basic properties, including grain size distribution, Atterberg limits, specific gravity, compaction characteristics, and California Bearing Ratio (CBR) values of RCA against those standard materials. The analysis classifies RCA gradation and deploys CBR tests and standard compaction tests to assess RCA's compatibility. The results reveal that RCA has a CBR value of 30.30, compared to 73.23 for SM01 and 49.49 for SM02. These findings suggest RCA has the potential to perform similarly to conventional materials, offering a sustainable alternative for pavement construction while maintaining the required performance standards.

Keywords: Unbound Granular Pavements; Unbound Granular Materials; Recycled Concrete Aggregate; Compaction Curve; CBR

ICSBE24_166

USE OF LFWD AS A NON-DESTRUCTIVE TEST TO ASSESS CONDITIONS OF A PAVEMENT STRUCTURE DURING CONSTRUCTION

H.D.S. Mithila*, K.A.S.N. Fernando, K. Monneron, S. Jayakody
Queensland University of Technology, Brisbane, Australia
**Correspondence E-mail: shehan.halahakoon@hdr.qut.edu.au, TP: +61404589312*

Abstract: The absence of a robust method to determine the quality conditions of pavement layers during construction poses a significant challenge in pavement engineering. Therefore, there is a substantial demand for a rapid, user-friendly, and non-destructive test method. The Light Falling Weight Deflectometer (LFWD) has gained an increasing interest for its potential applicability in this context. Therefore, this study investigated the use of LFWD within a controlled environment in a laboratory model box (1m x 1m x 1.2m) to evaluate the uniformity of compaction and stiffness of geosynthetic-reinforced weak subgrades. During the construction of model subgrade structure, the LFWD was used to measure the dynamic modulus at number of locations on top of each layer (in-situ subgrade and each 100 mm of the capping layer) to assess the uniformity of compaction. In order to assess the impact of gravel type, two gravel types were used. The average dynamic modulus of each level was used to quantify the stiffness improvement of the soft in-situ subgrade due to the capping layer thickness and the embedment of geosynthetic. The findings of the study suggest that the LFWD is an effective tool for quality control in the construction and compaction of pavements. However, it was also observed that the LFWD was not effective in detecting stiffness improvements due to geosynthetics when tested with a 100 mm granular cover over the geosynthetic. Furthermore, the results demonstrated that the use of LFWD effectively captured the improvement in overall pavement stiffness as the granular cover thickness increased. These results confirm that the LFWD device provides accurate and reliable measurements for quality control, emphasizing its utility in the construction of pavement structures to maintain uniformity in compaction.

Keywords: LFWD; Geosynthetic Reinforced Subgrades; Quality Control; Model Box

ICSBE24_023

ASSESSING THE ECO-LABELING LANDSCAPE IN SRI LANKA AND IDENTIFYING CRITICAL EXPORT PRODUCTS IN NEED OF ECO-LABEL CRITERIA DEVELOPMENT

M.L.F. Rilwana[1*], D. Lekamge[1], A.C.S.I. Mumthas[2]
[1]Department of Natural Resources, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya, Sri Lanka
[2]National Cleaner Production Centre, 14a Nalandarama Rd, Nugegoda, Sri Lanka
**Correspondence E-mail: fathimarilwana111@gmail.com, TP: +94763280029*

Abstract: Green marketing tools have been adopted to mitigate the adverse environmental impacts of consumption and production. Eco-labels are a green marketing tool that serves as an indicator to identify environmentally friendly products and services. This enables consumers to make informed decisions while purchasing products. At present eco-labeling is a novel concept in the Sri Lankan market. This study aimed to explore the eco-labeling landscape in Sri Lanka and identify the top export products of Sri Lanka that are in critical need of eco-label criteria development to expand their market. The investigation commenced with the identification of local and international eco-labels on Sri Lankan products by referencing the Ecolabel Index, recognized as the world's largest directory of eco-labels featuring 456 entries and other source materials. Next, the products with local eco-label criteria were identified and shortlisted based on the availability of Type I eco-label criteria developed by members of the Global Eco-labeling Network (GEN). This list was cross-referenced with the top 10 export products of 2022 to identify the critical export products of Sri Lanka that needed eco-label criteria developed. From the 41 eco-labels identified on Sri Lankan products, only 17.07 % were local, indicating a heavy reliance on international certification bodies. Among the local eco-label providers, only one institute was a member of the GEN, with criteria developed for only four product categories (tea, dairy, chemical constructions, and textiles and apparel). This indicates the necessity for further development of eco-label criteria for different products. Furthermore, product categories including coffee, spices, rubber, rubber articles, gems, precious metals, and electrical machinery were identified as critical export products that require Type I GEN member eco-labels to expand their export market further, as the European and other markets are increasingly focused on purchasing eco-friendly products.

Keywords: Environmental Certification; Global Eco-labeling Network; Type I Eco-label; Ecolabel Index

ICSBE24_024

DEVELOPMENT OF AN ECO-LABEL CRITERIA FOR RUBBER AND RUBBER-BASED PRODUCTS IN SRI LANKA

M.L.F. Rilwana[1*], D. Lekamge[1], A.C.S.I. Mumthas[2]
[1]Sabaragamuwa University of Sri Lanka, P.O.Box 02, Belihuloya
[2]National Cleaner Production Centre, 14a Nalandarama Rd, Nugegoda
**Correspondence E-mail: fathimarilwana111@gmail.com, TP: +940763280029*

Abstract: Eco-labels are tools used to inform consumers about the environmental friendliness of products. These labels indicate that the products are produced with reduced environmental impact, based on life cycle considerations. While this concept is still novel in Sri Lanka, international markets, particularly in Europe, recognize the importance of eco-friendly products. Sri Lanka produces numerous export products that face challenges in reaching eco-conscious markets. Therefore, the main objective of this research was to develop a comprehensive eco-labeling criteria for the product identified to have a priority need with respect to its economic and environmental significance to Sri Lanka. The methodology followed was adapted from ISO 14024:2018. Potential export products were analyzed based on their environmental impact using life cycle analysis literature. Three products with the highest environmental impacts were further evaluated for their economic significance, leading to the final selection. The life cycle of the selected product category was thoroughly reviewed to identify areas most relevant for reducing environmental impact at each stage. Criteria were weighted, and relevant documents and assessments required for compliance were listed with expert consultant. Based on economic and environmental significance, rubber and rubber-based products were identified as the most suitable. The main parts of the rubber product value chain include rubber plantation, processing and manufacturing. Key areas identified for impact reduction were water and soil conservation, energy conservation, raw material consumption, responsible chemical use, solid waste management, wastewater management, and air emissions. The eco-labeling criteria were developed to address these major and minor areas, weighted by importance for impact reduction. Compliance documentation and assessments were also outlined. The developed criteria can be reviewed by an expert committee and established by an eco-labeling body.

Keywords: Environmental Certification; Green Marketing; Product Sustainability; Sustainable Consumption

ICSBE24_040

THE POTENTIAL OF GREEN ENGINEERING DRIVEN BY CLIMATE MODELING DATA IN ACHIEVING ENVIRONMENTAL SUSTAINABILITY

R.M.C.L. Kavindi, H.M.Y.L. Herath*, A.B.M.C.W. Abeykoon, H.A.S. Nimasha
Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka
**Correspondence E-mail: yashodha2lakmali@gmail.com, TP: +94711887346*

Abstract: Driven by developments in climate modeling, green engineering is at the vanguard of attempts to attain environmental sustainability in the context of climate change issues. The revolutionary potential of incorporating climate modeling data into green engineering techniques is examined in this review paper. This study provides an extensive overview of several climate models and green engineering practices by combining information from a wide range of scientific literature, including Springer, Elsevier, ResearchGate and ScienceDirect etc. Thirty scientific documents from these sources have been investigated and filtered out between 2005 and 2024 with the ultimate goal to identify how climate models influence and improve green engineering practices in many industries, highlighting their contribution to resource efficiency and reducing environmental effect. The importance of using thermodynamic and hydrodynamic models to predict climatic patterns and simulate environmental effects, as well as the synergistic advantages of combining these models with green engineering principles, are discussed here. Case studies provide real-world examples of how climate data-driven methodologies have produced innovative, sustainable solutions in the fields of agriculture, infrastructure, and energy. Together with successful examples that demonstrate the viability and advantages of such interfaces, the paper also addresses integration issues, including data compatibility and interdisciplinary collaboration. In conclusion, this research emphasizes how crucial it is to use insights from climate modeling to propel innovative solutions in green engineering, arguing for their broad implementation to successfully handle environmental concerns around the world.

Keywords: Climate Change; Climate Modelling; Eco-friendly; Green Engineering; Sustainability

ICSBE24_043

THERMAL ENVIRONMENT OF URBAN SCHOOLS; A FIELD STUDY OF CLASSROOMS DURING HOT SEASON IN KANDY

D. Rathnayake[1], I. Rajapaksha[1], H.B. Rijal[2]
[1]Department of Architecture, University of Moratuwa
[2]Faculty of Environmental studies, Tokyo City University
**Correspondence E-mail: dhananjaliratnayake@gmail.com, TP: +94719569427*

Abstract: Climate change has caused overheating indoors, leading users towards heat stress on extremely hot days. Children, as a vulnerable age group, are significantly affected by heat stress given the substantial time spent in school classrooms which has become their primary living context. Over the past years, Sri Lanka faced a significant threat from extreme heat where the temperature surpassed 35□C. The study investigates indoor thermal behavior, exposure, and overheated conditions in naturally ventilated classrooms in urban settings. Field investigations were conducted at three schools in Kandy during the final two weeks of March 2024, targeting the hottest recorded days of the year. The indoor and outdoor thermal environment was recorded continuously over a week in all three schools and was used to assess the thermal behaviors, trends of overheated conditions, and the thermal environment of naturally ventilated classrooms. Additionally, the study observed that nighttime outdoor temperatures were significantly cooler than indoor temperatures, which directly contributed to overheated conditions inside classrooms during the day. Though the indoor air temperature was lower than the outdoor temperature during the daytime, the higher air temperature inside the classrooms at night has contributed to making classrooms during school hours to be overheated. Natural ventilation inside the classrooms after school hours and at night time and change of building materials could be identified to control the overheating at day time. The findings of the study are used to assess the thermal performance and thermal preference of students in future studies.

Keywords: Thermal Comfort; Naturally Ventilated Classrooms; Outdoor Air Temperature; Indoor Air Temperature; Thermal Behavior

ICSBE24_112

ANALYZING THE ACCOMPLISHMENT OF SUSTAINABILITY GOALS IN THE DEVELOPMENT OF TECHCITY IN SRI LANKA- A SPECIAL REFERENCE TO THE HOMAGAMA URBAN AREA

A.L.T. Subodha[1]*, Jeeva Wijesundara[1], W.A.S.S.S. Devinda[2]
[1]School of Architecture, Sri Lanka Institute of Information Technology, Sri Lanka
[2]Department of Management of Technology, University of Moratuwa, Sri Lanka
**Correspondence E-mail: subodha95thilini@gmail.com, TP: +94717908999*

Abstract: Technology city development has become a booming trend in the infrastructure development of the modern world, and the word "sustainability" is a federated feature in technology city (TechCity) development. A wide range of studies are implemented in this context; however, the literature has a lack to evaluate how far the development initiatives have accomplished sustainable cities and communities. This study analyses the realization of the sustainability goals, specifically sustainable cities and communities, in the TechCity development in Sri Lanka (Homagama area) in terms of environmental, social, and economic contexts. The considered population of this study is the middle-layer employees of the technology cities development industry in Sri Lanka. This study used a survey methodology and collected 150 responses through a self-administered questionnaire. Conferring to the results of simple linear regression analysis, the accomplishment of sustainability within the environmental, social, and economic contexts shows a positive relationship with the technology cities development. As captured by the one-way ANOVA test results, environmental sustainability is not significantly viewed, while economic and social sustainability are remarkably envisioned. The findings of this study benefit the decision-making of the construction industry and promote environmentally friendly developments of technology cities and healthy communities in such scenarios.

Keywords: Development of TechCity; Sustainability; Sustainable Cities; Sustainable Communities

ICSBE24_800

STRATEGIC MITIGATION OF GREENHOUSE GAS EMISSIONS: A COMPREHENSIVE REVIEW

M. Kiruciga*, M. Rammiya
Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri lanka
**Correspondence E-mail: mahendraraj4gt@ags.ruh.ac.lk, TP: +94770023833*

Abstract: Climate change has become a modern global trend after Kyoto protocol to address the global warming. Climate change refers to long-term shifts in temperatures and weather patterns primarily due to greenhouse gas emissions from both natural and anthropogenic systems. Particularly, those due to human activities have resulted in the increase of global surface temperatures by 1.1°C compared to the 1850-1900 period, as observed between 2011-2020. The emissions of greenhouse gases have persisted their growth, with unequal contributions historically and currently originating from unsustainable energy use, inappropriate land use, and diverse patterns of consumption and production among regions, countries and individuals. Natural phenomena such as forest fires, volcanoes and earthquakes have also significantly contributed to intense emissions and severe economic losses. Thus, the adoption of mitigation strategies become inevitable. This study aims to comprehensively review the existing mitigation strategies to reduce the greenhouse gas emissions and identify future trends and policy developments in the context of abating the Climate change. A comprehensive literature review was conducted on some publications from past decade, government reports, case studies, and policy documents. This review identifies some key approaches to reduce greenhouse gas emissions: conventional mitigation strategies which focus on CO_2 emissions which are from fossil fuel combustion, and negative emission mechanisms which are based on capturing and sequestering the accumulated atmospheric CO_2 as beneficial carbon stocks. These processes encompass clean development mechanisms, sustainable agriculture management practices, energy efficiency practices, adoption of renewable energy, improved zero waste concept, innovative transportation techniques. The insights gained from this review reveal that the conventional mitigation strategies cannot solely be capable of achieving the stipulated targets set by Kyoto Protocol and Paris agreement. Therefore, researchers have to focus on further enhancing the available technologies and unravel innovative and sustainable solutions to combat Climate change and greenhouse gas emissions.

Keywords: Carbon Dioxide Removal; Carbon Sequestration; Conventional Mitigation Strategies; Sustainable Agriculture; Zero Waste

ICSBE24_057

ANALYSIS OF GENOTYPE × ENVIRONMENT INTERACTIONS TO IDENTIFY ADAPTABLE MUNGBEAN (*Vigna radiate* (L) WILEZELC) GENOTYPES OVER DIVERSE ENVIRONMENTS

M.J.M.P. Kumararathna[1*], D.S. De. Z. Abeysiriwardena[2], E. K. E. C. Nayana[3], W.M.R. Kumari[4], R.R.P.S. Ariyawansha[1]

[1]Field Crops Research & Development Institute- Mahailluppallamma
[2]CIC Agri-Businesses Pvt (Ltd.)
[3]Gain Legume & Oil Crops Research & Development Institute- Agunakolapalassa
[4]Fruit Research &Development Institute, Horana
**Correspondence E-mail: priyanthikumara@yahoo.com. TP: +94765762702*

Abstract: Genotype x environment (GXE) interactions play a crucial role in identifying mungbean genotypes with stable performance across diverse environments. Understanding these interactions enables breeders to select adaptable genotypes that maintain high yield potential and stress resistance under varying climatic and environmental conditions. This study focuses on analyzing GxE interactions to identify mungbean genotypes with superior adaptability and stability, contributing to the development of resilient varieties for sustainable production. The present study was conducted to examine the genotype x environment (G x E) interactions for seed yield of mungbean genotypes in order to identify adaptable and stable genotypes over diverse environments. The trials were conducted in six locations during yala 2020 and maha 2020/21. Location × season combination was taken as an environment so that 12 environments were included in the study. Six mungbean genotypes were evaluated for their adaptability over diverse environments using regression and variance component methods for data analysis. In the regression method the linear regression coefficient and deviation from regression and in the variance component method variance of the genotypic deviations from the environmental means were used as stability parameters. In the study, adequate environmental diversity for a successful adaptability evaluation of mungbean genotypes was achieved. In both the regression and variance component methods, the GE interaction was found to be significant. Both the methods, evaluated adaptability of mungbean genotypes over diverse environments similarly. However, use of the variance component method and interpretation of results of that method appeared comparatively less complicated and much easier. The genotypes MMIB 14-254 and MIMB 14-156 were identified as the most and least adaptable genotypes, respectively. Both ANK 118 and MI 6 exhibited similar level of adaptability but less adaptable than ANK 41Meanwhile, ANK 48 was identified as a genotype with low adaptability.

Keywords: Adaptability; GE Interaction; Mungbean; Seed Yield; Stability

ICSBE24_146

ENABLING MARKET ACCESS FOR SMALLHOLDER CINNAMON FARMERS OF THE EASTERN SLOPE OF THE CENTRAL HIGHLANDS OF SRI LANKA: A DECISION SUPPORT SYSTEM

K.W.R. Himara[1*], P.K.D.H.S. Alahakoon[1], H.M.A. Imalka[1], P.A.D.T. Premarathna[1], S.L. Haputhanthri[1], D.A.M. De Silva[1], B.T.G.S. Kumara[2], S.D. Kumarage[2], A.S. Ambagahawatta[2]

[1]Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

[2]Department of Computing & Information Systems, Faculty of Computing, Sabaragamuwa University of Sri Lanka

**Correspondence E-mail: ruwandahimara128@gmail.com, TP: +94715726022*

Abstract: Ceylon Cinnamon (*Cinnamomum zeylanicum*) is a highly valued spice and medicinal plant, crucial for culinary, medicinal, and cosmetic applications, especially in exports. Being one of the most economically important crops in Sri Lanka, Ceylon Cinnamon has a significant impact on rural as well as the national economy. However, smallholder cinnamon farmers face numerous difficulties in reaching the market for their products due to price volatility and marketing issues. Disrupted supply chains and limited market opportunities have underscored the urgent need for the development of a robust market decision support system becomes crucial in linking cinnamon farmers to markets. The study aimed to identify existing market Decision Support Systems (DSS) for cinnamon and to design and develop market decision support for smallholder cinnamon growers. The Blueprint of the market decision support system defines the strategy to move forward, improve market access pathways to cinnamon smallholders, and identify the elements that have an impact on market positioning, branding, and communication planning. This approach ensures that both buyers and sellers can easily find suitable market partners, thereby improving market efficiency. In addition to market linkages, the DSS provides smallholder farmers with vital information on pests and disease management, enabling them to manage these challenges more effectively. By integrating these features, the DSS not only improves market access. This DSS provides separate modules for Buyers, Farmers, and Newsfeed, along with specific features like varieties for buyers, login profiles for farmers, and additional details in the newsfeed. The DSS aims to improve market accessibility and encourage sustainable farming practices for small-scale farmers, potentially decreasing pest-related losses. These expected impacts underscore the DSS's potential to enhance both economic and environmental sustainability for smallholder cinnamon growers.

Keywords: Decision Support System, Ceylon Cinnamon, Smallholder farmers, Blueprint

ICSBE24_389

A SYSTEMATIC REVIEW OF REMOTE SENSING APPLICATION IN RUBBER CULTIVATION AND RUBBER YIELD PREDICTION MODELS

H.W.N.O. Wadugoda[1*], T.A.N.T. Perera[1], G. Abhiram[1], G.Y. Jayasinghe[2]
[1]Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka
[2]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka
**Correspondence E-mail: oshankanw1998@gmail.com, TP: +94712091836*

Abstract: Rubber (*Hevea brasiliensis*) is a tropical tree cultivated for latex production and is considered one of the four primary industrial raw materials worldwide. Monitoring and managing rubber plantations adopting traditional methods can be challenging. This systematic review concentrates on (a) the application of developed innovative machine learning models for rubber yield prediction and (b) the utilization of remote sensing (RS) techniques in rubber cultivation and (c) future challenges & research opportunities leading to long-term deployment. This review analyses 50 studies published in English from 2010 to 2024, sourced from Google Scholar. Based on search criteria, 127 relevant studies were retrieved initially, of which 50 studies were selected for further analysis using inclusion and exclusion criteria. Previous studies were searched using the following search string: 'Remote Sensing' or 'Satellite Image' & 'Rubber plantation' and 'Rubber yield prediction'. Different research findings reveal that RS data have been gathered through Satellites, Airborne platforms, or Unmanned Arial Vehicles (UVAs) for crop mapping, yield prediction, data collection, decision making, and management practices. The extraction of information about rubber plantations from RS data has been a major subject area of recent academic research. The review uncovers that RS has substantially assisted rubber cultivations through enormous ways, including cultivation planning, hydrology monitoring, biomass and girth assessment of rubber trees and tree counting. Nonetheless, the review shows a noticeable gap in studies focused on rubber yield prediction. For such solutions to be applied across various disciplines, several challenges such as lack of training data, insufficient effective, efficient and portable models, and understanding of the predictions made by artificial intelligence should be addressed. This review therefore urges for more research and development of remote sensing and machine learning to enhance rubber plantations and yield estimated prognosis.

Keywords: Machine Learning; Predictive Models; Remote Sensing; Rubber Plantation; Yield Prediction

ICSBE24_481

RELEASE PROFILES OF GIBBERELLIC ACID: USING DIFFERENT POLYMER BLEND CARRIERS WITH NANO TiO_2

D.N.A. Arachchi[1,2], Rohini M. De Silva[1*], K.M. Nalin De Silva[1]
[1]Department of Chemistry, University of Colombo, Sri Lanka
[2]Department of Limnology and Water Technology, University of Ruhuna, Sri Lanka
**Correspondence E-mail rohini@chem.cmb.ac.lk, TP: +94714406263*

Abstract: This work concerns the development of two novel chitosan-based carriers namely, chitosan/alginate/nanoTiO_2 (CS/AL/TiO_2) and chitosan/pectin/nanoTiO_2 (CS/PC/TiO_2) for the encapsulation of Gibberellic Acid (GA_3), a plant growth regulator, and the comparative investigation of their release profiles. The carrier systems with the same polymer blends were also prepared without TiO_2 nanoparticles for comparison. All the carrier systems were prepared by gelation method, with each containing 50 µg mL^{-1} of the final concentration of GA_3. The releasing studies were carried out using a system with acceptor and donor compartments, where the donor compartment is a cellulose membrane with a 14 kDa exclusion pore size. Samples, including carriers and free GA_3, were separately placed in donor compartments. The acceptor compartment contained $CaCl_2$ solution (11 mM) for all the systems. Aliquots were periodically collected from the acceptor compartments, and cumulative releasing percentages were determined at room temperature, at two different pH (pH 2 and 8), using a UV-visible spectrophotometric method. CS/AL/TiO_2 showed 6.58 % and 13.16 % release after 6 hrs at pH 2 and 8, respectively, while that for the carrier without TiO_2 was 7.89 % and 14.21 %. For free GA_3, those values were 14.47 % and 19.74 %, respectively. Both the free GA_3 and CS/AL reached a maximum release after 72 hrs with releasing percentages of 74.94 %, 60.59 % at pH 2, 91.57 %, and 85.56 % at pH 8, respectively. For the CS/AL/TiO_2, the maximum release of 91.27 % at pH 2 and 96.29 % at pH 8 were observed after 96 hours. For the PC-based carriers, the maximum release percentage was recorded as 84.01 % for the CS/PC/TiO_2 at pH 8 after 96 hrs, while the maximum release percentage for CS/PC was 56.29 % at pH 8 after 72 hrs. Both the chitosan-based carrier systems blended with AL and PC showed greater release at higher pH, implying that alkaline media facilitate the release of GA_3 than in acidic conditions. Further, carriers incorporated with TiO_2 showed an enhanced release. Moreover, results suggested that AL-based carrier systems are better than PC-based systems for the effective release of GA_3.

Keywords: Chitosan; Alginate; Pectin; TiO_2

ICSBE24_482

IDENTIFY THE IMPACT OF CRYOPROTECTANTS ON THE BIOMASS PRODUCTION AND CELL VIABILITY OF *Chlorella* sp. AND *Oscillatoria* sp. AT ULTRA-LOW TEMPERATURES

I.G.S.S. Ekanayaka[1*], B.L.W.K. Balasooriya[1], S.M.S.N. Senanayake[2]
[1]Department of Biotechnology, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka
[2]Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, (CP), 20400, Sri Lanka
**Correspondence E-mail: savinisiri@gmail.com, TP: +94725994626*

Abstract: Microalgae and cyanobacteria are two extremely diverse groups of organisms in greater demand as potential contenders for the global bio-economy of the future. Batch and serial transfer techniques are used to maintain pure cultures of microalgae. However, the methods are not efficient in the long-term due to possible cross contaminations and reduction of genetic stability. In this study, the effect of low temperature (-20°C, -80°C) storage with three cryoprotectants (10 % glycerol, 10 % methanol, 10 % Polyvinylpyrrolidone) on the preservation of pure cultures of *Chlorella* sp., and *Oscillatoria* sp. were studied. Each species' growth curve was developed to identify the exponential growth phase. Two species were stored at -20 °C and -80 °C along with three cryoprotectants. The viability was assessed at different time intervals using the dye exclusion method. The longest exponential phase was observed in *Oscillatoria* sp. (144 hrs to 718 hrs) while *Chlorella* sp. showed the highest specific growth rate (0.027 hrs^{-1}). After one month of storage of *Chlorella* sp. at -20 °C, the highest mean biomass growth was observed with 10 % methanol followed by 10 % Polyvinylpyrrolidone and 10 % glycerol compared with the control. At -80 °C storage of the species, biomass growth was not significantly different among the cryoprotectants. In *Oscillatoria* sp., the highest mean biomass production at both -80 °C and -20 °C storage was observed in 10 % glycerol. At -20 °C, *Chlorella* sp. indicated the highest cell viability with glycerol (62.4 %) and PVP (62.2 %). At -80 °C, 10 % methanol (60.5 %) showed the highest viability of *Chlorella* sp. while glycerol (63.9 %) in *Oscillatoria* sp., and both glycerol (59.4 %) and methanol (60.5 %) resulted significantly higher cell viability at -20 °C. Both -20 °C and -80 °C can be used to store for one month with high viability. At -20 °C glycerol and methanol were the best to store *Oscillatoria* sp. Glycerol and polyvinylpyrrolidone were equally effective in storing *Chlorella* sp. at -20 °C but methanol is the best cryoprotectant to store the species at -80 °C.

Keywords: Biomass Growth; Cell Viability; *Chlorella*; Cryoprotectants; Microalgae; *Oscillatoria*

ICSBE24_484

DEVELOPING A COST-EFFECTIVE TISSUE CULTURE MEDIA FOR BANANA (*KOLIKUTTU*) ROOT INDUCTION

M.M.S.M. Nishshanka[1], K. Herath[2*]
[1]*Faculty of Technology, University of Jaffna, Ariviyalnagar, Kilinochchi, Sri lanka*
[2]*TC Plant, Biotechnology Company, Moragahahena Road, Homagama, Sri lanka*
**Correspondence E-mail: info@tcplant.com TP: +94777999348*

Abstract: *Kolikkuttu*' is one of the most popular man-made hybrids, which has a higher demand in commercial Banana markets. Cost-effective tissue culture protocols have been established for the commercial multiplication of *Kolikuttu* banana variety. Planting materials of this Banana variety are produced mainly through in vitro techniques using Murashige and Skoog (MS) medium, RO water (Reverse Osmosis water) and Agar. Small scale growers cannot afford readymade MS powder and other solutions to make the medium due to high cost. If a low-cost fertilizer that performs equally well as the MS medium can be introduced. Therefore, this study was conducted with readily available fertilizer to test the applicability to develop a medium for root induction. The investigation was carried out at the tissue culture laboratory of the TC Plant as an experiment using Albert's solution (6 g/L), Urea (2 g/L), AC effluent water and Moss Jelly (10 g/L). Experiment was conducted in a Completely Randomized Design (CRD). The prepared media were autoclaved for 20 minutes at 121 ^{0}C. After, the rooting process was conducted under a laminar flow cabinet. All the culture jars were kept under 1000-2000 lux light intensity at 25 ^{0}C in 75-80 % relative humidity. After four weeks, number of roots, length of the roots, number of leaves were measured and analysed using Minitab computer software package. Highest mean plant growth was observed in this media. No significant differences were recorded between control medium and prepared media. Therefore, it can be concluded that the best medium to replace MS medium, RO water and Agar for growing plant is media formulation with 2 g/L urea, 6 g/L Albert's solution Moss jelly (10 g/L) and AC effluent water. This cost-effective solution holds great promise for enabling small-scale cultivators to efficiently propagate the *Kolikkuttu* banana variety.

Keywords: Banana, Tissue Culture, Propagation, Cost-effective Formulations

ICSBE24_684

DURABILITY CHARACTERISTICS OF CONCRETE WITH SURFACE-TREATED CALICUT TILE AGGREGATES

J. Johnkeshanth[1], H.M.C.C. Somarathna[1,2*], S. Kishotharan[1], M. M. M. Kaashif[1]
[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka
[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka
**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: This research investigates the innovative application of treated Calicut Tile Aggregates (CTA) in concrete production, showing a sustainable path within the construction sector. The methodology incorporates the enhancement of CTA's intrinsic characteristics via a cementitious coating technique, aiming to increase its utility as a substitutive material for traditional coarse aggregates. The aim of this investigation pivots on a comprehensive assessment of the durability characteristics of concrete incorporating treated CTA. The treatment process involved the application of a cement-sand coating on raw CTA, adhering to a predetermined cement-to-sand ratio of 1:2. This study analysed the resilience of the modified concrete against material degradation due to three distinct environmental conditions: acidic, alkaline, and saline. Observations pointed to a notable reduction in weight loss across all testing environments, attributable to the protective efficacy of the surface treatment. This phenomenon was consistently noted across two different exposure periods of the concrete. A pivotal finding from this investigation was the differential impact of the exposure environments on the concrete's integrity. Specifically, conditions of acidic exposure resulted in the most substantial material degradation, while saline environments were associated with the least extent of weight loss. This divergence underscores the key role of the cement sand coating in enhancing the durability of the treated CTA against aggressive agents, thereby extending the functional lifespan and enhancing the overall durability of the concrete infrastructure. This research underscores the significant potential for the utilization of treated CTA in concrete production, aimed at improving structural resilience against corrosive agents.

Keywords: Calicut Tile Aggregates; Aggregate Treatment; Cement Sand Coating; Concrete

ICSBE24_086

INVESTIGATING EARLY-AGE STRENGTH OF HIGH-STRENGTH CONCRETE MADE OF HIGH-STRENGTH CEMENT PASTE AND HIGH-GRADE AGGREGATES

R. Anushan[1*], K.M.C. Konthesingha[1], I.R. Upasiri[1], A. Branavan[2], P.M.W.P. Kumara[1], D.A.D.N. Dissanayake[1]

[1]Department of Civil Engineering, University of Sri Jayewadenepura, Sri Lanka
[2]School of Civil and Environmental Engineering, Queensland University of Technology (QUT), Australia
**Correspondence E-mail: en93876@sjp.ac.lk, TP: +94718849073*

Abstract: High-strength concrete (HSC) with a compressive strength of over 41 MPa improves concrete sustainability, and it is crucial for modern construction of skyscrapers. The strength of HSC depends on the water-to-binder (w/b) ratio, and the type and content of aggregate and admixture. While most studies have investigated the effects of these parameters individually, only a few have explored their combined effects. This study investigates the early-age strength of HSC using locally available high-grade rock-derived aggregates and high-strength cement paste (HSCP). The overall experimental program is divided into two phases: firstly, a HSCP with a w/c ratio of 0.25 was prepared using a triple blend concept with silica fume (SF), fly ash (FA), and high range water reducer (HRWR), and secondly, the optimum HSCP developed in the first phase was used to prepare high-strength cement mortar (HSCM) with the use of river sand (RS) and manufactured sand (MS). Based on the maximum compressive strength results, the optimal content was determined as 6% SF, 7.5% FA, 1% HRWR, 35% RS, and 65% MS. Finally, different grades of HSC such as C50, C60, C70, and C80 were prepared using these optimized constituents and high-grade aggregates from Hornblende-Gneiss rock. The developed HSCs achieved a strength ranging from 86% to 97% within the first seven days, reaching the 28-day target strength which proved possibility of speed construction and time savings.

Keywords: High-strength Concrete; High-grade Aggregates; Blended Sand; Triple Blend Concept; Optimization

ICSBE24_203

PREDICTING THE DURABILITY OF WALLING UNITS BY IDENTIFYING MOSS GROWTH THROUGH IMAGE PROCESSING

L.R. Irudhiyarajah[1*], Akarshani Amarasinghe[2], I.R.Upasiri[1]
[1]Department of Civil Engineering, University of Sri Jayewadenepura, Sri Lanka
[2]Department of Computer Engineering, University of Sri Jayewadenepura, Sri Lanka
**Correspondence E-mail: roshildairudhiyarajah@gmail.com, TP: +94766818238*

Abstract: Moss growth in walling elements in buildings is a common cause of phenomena due to water accumulation and weathering conditions over a period. The presence of moss can lead to increased porosity, water penetration, and freeze-thaw deterioration, all of which can compromise the structural integrity of walling elements. Additionally, it speeds up the corrosion of steel reinforcement if any and aids in the breakdown of the components. The study focuses on the visual inspection techniques used to evaluate the effects of moss development on walling units and structural integrity especially Brick, Cement Block, and Cabook Block. Researchers utilized visual inspections and photographic documentation to track and quantify moss covering over time, identifying growth levels, water ingress, and moisture-related issues. Image processing is a significant trend in Computer Science, enabling the identification and analysis of color differences using the Red-Green-Blue (RGB) ratio. The study uses an image processing approach and the K-Means Clustering Algorithm to determine the RGB ratio and identify the predominant color of each walling unit each week. The study reveals that moss maturity increases green (G) values, decrease red (R) values decrease, and fluctuate blue (B) values due to environmental conditions. Cabook Blocks have the most extensive moss coverage, followed by Brick walls, and Cement Blocks have the least coverage. And this could be extended to predict the age of moss and durability of the walling units by only taking an image of the moss-grown wall.

Keywords: Moss Growth; Walling Units; Image Processing; RGB Ratio; K-means Clustering**;** Durability

ICSBE24_041

INVESTIGATING THE EFFECT OF DIFFERENT MIX PERCENTAGES OF GRAPHENE OXIDE ON THE ABRASION RESISTANCE OF CONCRETE

I.D.S.E.M. Dewage[1], T.M. Perera[1*], I.S.K. Wijayawardane[2]
[1]Faculty of Technology, University of Sri jayewardenepura/Dampe – Pitipana Rd, Homagama.
[2] Faculty of Engineering Technology, The Open University of Sri Lanka/Nawala, Nugegoda
**Correspondence E-mail: manori@sjp.ac.lk, TP: +94772514814*

Abstract: This research investigates the effect of various mix percentages of graphene oxide (GO) on the abrasion resistance of concrete made using fly ash-blend cement. It will emphasize the mechanical and durability properties of GO-modified concrete in terms of compressive strength, tensile strength, workability, setting time, and abrasion resistance. Hence, selection will be done based on the appropriate GO mix percentage that is achievable at the average setting time. Concrete samples were cast in varied concentrations of GO (0.04%, 0.08%, and 0.12%). The 0.08% GO had 9.2% betterment than the control specimen and was raised to a maximum compressive strength of 54.63MPa. The improvement is backed by better particle distribution and a reduced number of micro voids. Still, the 0.12% sample showed a slight reduction in strength compared to the other specimens, likely due to particle aggregation of GO. The concrete's workability also decreased with the addition of GO, but the reduction trend is gradual. GO also significantly increased the concrete's setting time. Here, the setting time prediction from the given graph has resulted in the statement that GO increased the setting time, and for the maximum concentration, the setting times were the lowest. According to the results of the abrasion resistance tests, it is clear that GO improves the concrete's durability against surface wear. The tests revealed that the 0.12% GO sample was the best and had the lowest abrasion coefficient. These results have strong practical implications for the construction industry in that GO-enhanced concrete is applicable to adverse service environments and, at the same time, to the fast-tracking of construction. Recommend independent research on long-term durability, microstructural interaction, workability optimization, environmental impact, and field trials to validate laboratory findings and real-world performance.

Keywords: Graphene Oxide Concrete; Abrasion Resistance; Compressive Strength; Concrete Workability; Sustainable Construction

ICSBE24_084

STRUCTURAL REHABILITATION USING ULTRA-HIGH-PERFORMANCE FIBER-REINFORCED CONCRETE (UHPFRC) JACKETING

K.R.S. Prabhashwara*, W.D.M. Ruwansara, S. Bandara
Department of Civil Engineering, University of Peradeniya, Peradeniya 20400, Sri Lanka
**Correspondence E-mail: e18262@eng.pdn.ac.lk, TP: +94768552562*

Abstract: Structural rehabilitation and retrofitting is a crucial aspect considering the financial feasibility and sustainable aspects when compared with demolition and replacement of structures. Structural retrofitting improves the durability, performance, and safety of existing structures. This study involves structural rehabilitation using Ultra-high-Performance Fiber Reinforcement Concrete (UHPFRC) jacketing and focuses on retrofitting shear-critical beams. Mechanical properties, mix proportions, and material behavior of UHPFRC are investigated deeply before numerically simulating the behavior of UHPFRC retrofitted shear critical beams. A numerical model of a shear critical reinforced concrete beam retrofitted with UHPFRC was developed and validated using existing experimental data. The Concrete Damage Plasticity (CDP) model was used for simulating the nonlinear behavior of concrete and ABAQUS software was used to perform finite element analysis. The failure modes, crack pattern, and load-displacement curves of the control and UHPFRC retrofitted reinforced concrete beams are compared. A parametric study was conducted using the validated numerical model to investigate the behaviour of shear critical reinforced concrete beams retrofitted with different configurations of UHPHRC jackets. Change of the brittle shear failure mode to ductile flexure and a significant enhancement of the load-carrying capacity was observed with UHPFRC jacketing. These results demonstrated the potential of UHPFRC jacketing for structural rehabilitation.

Keywords: Structural Retrofitting; UHPFRC; Jacketing; Shear Failure; Concrete Damage Plasticity

ICSBE24_805

EFFECT OF SEA SHELL CONTENT ON THE MECHANICAL PROPERTIES OF SEA SAND CONCRETE

Anuradha Koswaththa*, Samith Buddika, Hiran Yapa
[1]*Department of Civil Engineering, University of Peradeniya, Peradeniya 20400, Sri Lanka*
**Correspondence E-mail: anuradhakoswaththa@gmail.com, TP: +94778609434*

Abstract: Sea sand extraction in Sri Lanka started in the early 1990s and sand sea sand has been introduced as the main fine aggregate alternative during the past three decades. By the way, sea sand is still popular among local contractors for various reasons. To meet the standard given for sand for construction, sea sand is processed by washing and sieving to remove the water-soluble chloride and sea shells (SH) larger than 4 mm from the sea sand. But still sea shells size less than 4mm are a major concern among local contractors. This study investigated the effect of sea shells present in processed sea sand on the mechanical properties using cement mortar. Based on the field on shell content data of processed sea sand over the period from 2019 to the present shell content varies between 1% to 4 %. This experiment used up to 5% of shells as an addition to shells-free sea sand. Experiment results reveal that workability generally decreases with the increasing shell content from 1% to 4% SH but increases at 5% SH. Workability can be maximized using superplasticizers and is generally stable across different shell content with minor variations. Compressive strength for 7-day samples generally increases with the addition of up to 2% SH and then slightly decreases but remains higher than the control without SP. Compressive strength at 28- days remains relatively consistent from 0% to 5% SH, indicating that SH content does not significantly impact the long-term strength within this range. In conclusion, early strength is enhanced with the use of SP and optimal at 2% SH. Long-term strength remains consistent across different SSH contents, indicating no adverse effects of SSH on the compressive strength of sea sand concrete within the studied range.

Keywords: Sea Sand, Compressive Strength, Concrete, Sri Lanka

ICSBE24_793

EVALUATION OF MODULUS OF ELASTICITY PREDICTIONS FOR ULTRA-HIGH-PERFORMANCE FIBER-REINFORCED CONCRETE (UHPFRC)

Kalpa Gamage*, Sandaru Wijesundara, Isuru Abeykoon, Sahan Bandara, Kushan Wijesundara
University of Peradeniya, Sri Lanka
**Correspondence E-mail: e17093@eng.pdn.ac.lk, TP: +94775627903*

Abstract: The Modulus Of Elasticity (MOE) is a fundamental parameter in designing and analyzing Ultra-High-Performance Fiber-Reinforced Concrete (UHPFRC) structures, influencing their deformation behavior, stress distribution, and serviceability. Accurate estimation of the Modulus Of Elasticity (MOE) is crucial for ensuring structural integrity under diverse loading conditions. However, measuring the MOE often demands experimental testing since the mixed proportions and the materials used can vary significantly. As an alternative, engineers commonly use prediction equations based on compressive strength to estimate MOE. Nevertheless, further research is necessary to evaluate the applicability of these equations to UHPFRC of different strength ranges, particularly when incorporating local materials as partial replacements. This study aims to review and evaluate the performance of existing MOE equations for UHPFRC from the literature, with an emphasis on their accuracy and applicability to different UHPFRC strength categories. Incorporating local materials into UHPFRC enhances sustainability by lowering both the carbon footprint and production costs. However, this approach can influence mechanical properties, such as the MOE, potentially affecting the concrete's overall performance. This study aims to evaluate current MOE prediction models, identify their trends and limitations, and assess their applicability to UHPFRC applications. Findings of this study will provide a thorough understanding of how different mix compositions affect the MOE of UHPFRC. It will offer practical insights for engineers and researchers in designing UHPFRC structures with optimized mechanical performance, contributing to expanding the use of UHPFRC in construction, particularly in regions where local material availability and sustainability are key considerations, while ensuring structural safety and efficiency without the need for huge experimental testing.

Keywords: UHPFRC; Compressive Strength; Modulus of Elasticity; Steel Fiber

ICSBE24_901

INFLUENCE OF RUBBER PARTICLE SOURCE AND MORPHOLOGY ON THE MECHANICAL PROPERTIES OF AQUA-THERMALLY TREATED RUBBERIZED CONCRETE

B.G.V. Sanjaya[1,2*], J.M.R.S. Appuhamy[2], W.M.K.R.T.W. Bandara[2], S. Venkatesan[1], R.J. Gravina[1,3]

[1]School of Engineering, RMIT University, Melbourne, Australia
[2]Faculty of Engineering, University of Ruhuna, Galle, Sri Lanka
[3]School of Civil Engineering, The University of Queensland, St Lucia, Australia
**Correspondence E-mail: S3959393@student.rmit.edu.au, TP: +94714771808*

Abstract: Rubber pretreatment is pivotal in alleviating the inherent strength losses commonly observed in rubberized concrete. However, most contemporary treatment methods exhibit inconsistent improvement, compromising their adaptation in practical scenarios. Furthermore, some studies have pinpointed that the performance gain does not sufficiently justify the effort and expenses incurred in the treatment process. Notably, the aqua-thermal treatment method proficiently addresses these challenges, showcasing a remarkable enhancement in the strength of rubberized concrete. This approach combines water-based and heat treatment to produce relatively stiffer rubber aggregates by eliminating most impurities and textile particles adhered to the raw rubber. This formation established a stronger bond at the rubber/cement interface, thereby enhancing the mechanical performance of concrete. Subsequently, these findings suggest the potential of utilizing rubberized concrete in structural applications. However, the source, size, and morphology of rubber particles could also influence the treatment efficacy, underscoring the imperative for further research into aqua-thermally treated rubberized concrete. Hence, this study evaluated the impact of particle size and shape on the mechanical performance of aqua-thermally treated rubberized concrete using crumb rubber particles sourced from three different origins. The findings from this investigation revealed a slight variation in compressive strength, while flexural strength remained mostly unchanged across different rubber sources. Notably, the workability of concrete was significantly affected by irregular rubber particles. Overall, well-graded rubber particles demonstrated optimal workability and enhanced mechanical performance, underscoring the influential capacity of the aqua-thermal treatment in real-world applications.

Keywords: Aqua-thermal Treatment; Rubberized Concrete; Strength Recovery; Crumb Rubber; Particle Size

ICSBE24_006

CURRENT PRACTICES OF DEMOLISHED CONCRETE WASTE MANAGEMENT IN BUILDING PROJECTS IN SRI LANKA

S.S. Hettihewa*, D.R. Dasasnayake
Department of Construction Technology, Faculty of Technology, Wayamba University, Lional Jayathilaka Mawatha, Kanadulla, Kuliyapitiya, 60200, Sri Lanka
**Correspondence E-mail: Sitharuhettihewa99@gmail.com, TP: +94715218128*

Abstract: In Sri Lanka, the construction industry plays a pivotal role in the economic development of the country, which experienced rapid expansion, driven by urbanization and increased investment in residential, commercial, and infrastructure projects. However, this growth has also led to a substantial increase in construction waste, particularly demolished concrete waste, which poses environmental and logistical challenges. The management of demolished concrete waste is a critical component of sustainable construction practices, especially in developing countries like Sri Lanka. This study investigates current practices related to demolished concrete waste management in construction projects in Sri Lanka. Data was collected through a quantitative data collection method, where an online questionnaire survey was distributed among selected constructional professionals. The study identifies causes for demolished waste generation as well as prevailing methods practiced in managing demolished concrete waste and suggestions for effective waste management techniques. Through the findings, it was revealed that there is a significant reliance on traditional disposal methods in most of the construction projects in Sri Lanka, with limited adoption of recycling. The study concludes with recommendations for policy improvements, increased awareness, recycling benefits, and the promotion of sustainable waste management practices to enhance the environmental and economic outcomes of the construction industry in Sri Lanka.

Keywords: Sustainability; Demolished Concrete Waste; CIDA; Construction Industry; 3R; Landfill; Waste Management

ICSBE24_016

OVERCOMING BARRIERS IN IMPLEMENTING LEAN CONSTRUCTION PRACTICES IN THE BUILDING CONSTRUCTION INDUSTRY IN SRI LANKA

L.S. Weerasinghe[1*], I.W.N. Bandaranayake[1,2], A.K. Kulatunga[1]
[1]University of Peradeniya, Peradeniya, Sri Lanka
[2]University of Wollongong, NSW, Australia
**Correspondence E-mail: lahiru.sw91@gmail.com, TP: +94772772176*

Abstract: Building construction industry plays an important role in Sri Lanka's economy. However, the industry lags in improving labor productivity when compared to other industries. Lean Construction presents a fundamental change in organizational behavior and workplace culture. It is a conceptual framework focusing on waste reduction and value maximization. There is a dearth of studies on Lean Construction (LC) and identification of barriers to implement lean construction in the building construction industry in Sri Lanka. This research explores the perceptions of professionals engaged in the building construction industry in Sri Lanka to identify the barriers to implement LC practices. A comprehensive literature review formed the basis for the design of a survey questionnaire and interviews for the empirical phase of the study. The study discovered that the lack of training on lean methods and poor awareness were the main barriers for implementation of LC. As such, training and awareness of LC practices, along with change management programs, are necessary to help workers and employees overcome these barriers. As a strategy to overcome barriers to implementing LC, the government must also support and encourage the application through incentives and educational programs.

Keywords: Lean Construction; Barriers for Lean Construction; Building Construction Industry in Sri Lanka

ICSBE24_026

MINIMIZING MATERIAL WASTES THROUGH THE APPLICATION OF LEAN PRINCIPLES: A STUDY OF CONSTRUCTION PHASE OF HIGHEST GRADE CONSTRUCTION COMPANIES IN SRI LANKA

M.M. Dissanayaka, M.M.D.R. Deegahawature*
Department of Construction Technology, Faculty of Technology, Wayamba University, Lional Jayathilaka Mawatha, Kanadulla, Kuliyapitiya, 60200, Sri Lanka
**Correspondence E-mail: dharsana@wyb.ac.lk, TP: +94714461100*

Abstract: This research investigates the integration of lean principles into building construction to improve sustainability by minimizing material waste. Material waste in construction is a significant issue, with wastage rates in Sri Lanka reported to range from 5 % to 25 % of total materials purchased. Lean construction principles view material waste as a barrier to value flow and emphasize its elimination to enhance efficiency and sustainability. The study aims to explore how lean principles can reduce material waste in the building construction industry. Objectives include identifying the causes of material waste, evaluating current practices, assessing construction workers' awareness of lean principles, identifying lean practices for waste reduction, and proposing a framework to minimize waste. Data was collected through questionnaires, group discussions, and site observations, targeting senior-level professionals in the construction industry. A total of 171 participants from leading construction companies responded. Statistical analysis was conducted using SPSS and the Relative Importance Index (RII) method to rank the identified causes of material waste. The study identified the primary causes of waste as poor communication, low-quality product selection, last-minute client requirements, unclear quantities due to improper planning, and waste from cutting uneconomical shapes. Lean tools for waste reduction identified in the study include Just in Time, Pareto Analysis, Continuous Improvement, Kanban Systems, Waste Elimination, and Ishikawa Diagrams. Based on these findings, a framework for minimizing material waste through the application of lean principles is proposed. This research provides valuable insights for both academic and industry practitioners, promoting sustainable construction practices and environmental stewardship in the built environment. The study contributes to advancing lean construction techniques, offering a pathway to reduce waste and enhance sustainability in construction projects.

Keywords: Construction Industry; Lean Construction; Causes of Material Wastes; Lean Principles; Construction

ICSBE24_052

SUITABILITY OF FIBER MOLDING WASTES AS FINE AGGREGATE FOR CASTING PAVING BLOCKS

W.P.M. Dilsara, D.R. Dassanayake*
Department of Construction Technology, Faculty of Technology, Wayamba University, Lional Jayathilake Mawatha, Kanadulla, Kuliyapitiya, 60200, Sri Lanka
**Correspondence E-mail: wpdilsara1999@gmail.com, TP: +94774992345*

Abstract: Problems associated with waste generation from different industrial productions have escalated with technological advancements worldwide. Fiber Molding Wastes (FMW) are a prime example required proper management. Recycling wastes is an effective solution for reducing environmental impacts, conserving natural resources and enhancing sustainable development. Hence, the utilization of waste materials in construction is crucial for sustainable development. This study explores the suitability of FMW as Natural Fine Aggregate (NFA) for casting paving blocks sized 200 mm × 100 mm × 60 mm. Initially, materials were tested following British Standards (BS). Three percentages of crushed FMW: 10 %, 15 %, and 25 %, were utilized to substitute NFA in M15 grade concrete mixture prepared using the British Department of the Environment (DOE) mix design method to cast paving blocks. Simultaneously, control samples of paving blocks were produced and cured in water for various durations to evaluate the optimal product. Subsequently, block samples were tested for compressive strength at 7 and 28 days and water absorption properties. Additionally, how the Water-Cement (W/C) ratio was influenced by the compressive strength of three FMW mixed paving blocks can be identified. The outcomes showed that with an increment of the W/C ratio value, the compressive strength of paving blocks was decreased, and the highest compressive strength was achieved by a concrete mixture with a 0.791 W/C ratio. Furthermore, it was observed that increasing the replacement of FMW led to higher water absorption results. Ultimate compressive strength test results demonstrated that gradual decrease in compressive strength with the increase of substituting crushed FMW as NFA. However, the study concluded that as per SLS 1425 - Part 1:2011, paving blocks containing up to 25 % FMW that exhibited compressive strength exceeding 15 MPa after 28 days satisfied pedestrian requirements excluding vehicle accesses.

Keywords: Fiber Molding Wastes; Recycling Wastes; Natural Fine Aggregate; Compressive Strength; Water Absorption

ICSBE24_056

A QUANTITATIVE ANALYSIS OF IMPLEMENTING CIRCULAR ECONOMIC PRACTICES TO MANAGE CONSTRUCTION AND DEMOLITION WASTE IN SRI LANKA

Saumya Perera[1], Udayangani Kulathunga[1*], Panchali Weerakoon[1], Tennakoon Mudiyanselage Maheshi Pabasara Tennakoon[2]
[1]University of Moratuwa, Katubedda, Sri Lanka
[2]University of South Australia
**Correspondence E-mail: ukulatunga@uom.lk, TP: +94719523860*

Abstract: Construction and Demolition (C & D) waste management has become one of the major social issues worldwide. The Circular Economy (CE) is a strategy that has been introduced by the Ellen MaCarthy Foundation (EMF) as a way forward towards a sustainable construction industry. As a framework to implement CE strategy ReSOLVE framework has been developed based on six main actions of CE. This study aims to quantitively analyse the implementation of the Circular Economy concept through the ReSOLVE Framework for Construction and Demolition waste management in Sri Lanka. A conceptual framework has been developed as the outcome of the literature review, which consists of six main actions of the ReSOLVE framework and C&D waste management practices under each action. This study has incorporated a quantitative approach, and data was collected with the use of 30 responses for the questionnaire survey and the data has been analysed with the use of the Relative Important Index (RII). For the presentation of the findings, spider diagrams have been used, clearly indicating the difference between the level of practice and the importance of each practice. The findings of this study concludes that less attention has been given to the identified practices such as; building deconstruction, detect the construction activities that can admit reusable materials, maintaining proper quality assurance process to market secondary materials produced from C & D recycling, minimising the amount of raw materials stored on-site and use modern construction technologies in the construction industry within the ReSOLVE framework.

Keywords: Construction and Demolition Waste; Circular Economy; ReSOLVE Framework; Construction Industry; Sri Lanka

ICSBE24_676

BARRIERS TO IMPLEMENTING WASTE MANAGEMENT STRATEGIES IN CONSTRUCTION PROJECTS IN QATAR

T.D. Denagama*, J.M.I.S. Jayasundara
University of Vocational Technology, 100, Kandawala Road, Ratmalana
**Correspondence E-mail: tdenagama@yahoo.com, TP: +94714972340*

Abstract: Waste management is a hard problem on a global scale because there aren't many ways to deal with it. High-income Middle Eastern countries like Saudi Arabia, Qatar, UAE United Arab Emirates, and Bahrain which are all members of the Gulf Cooperation Council (GCC) are some of the biggest waste producers per person in the world. Only 10–15 percent of the waste in the area is recycled, which shows that the recycling industry is not well-developed there. Among these Middle Eastern countries, infrastructure and development projects in Qatar contribute to a country's growth and, as a result, they are facing a high generation of construction waste. The government of Qatar has said that waste management is one of the country's most serious environmental issues. Qatar generates around two and half million tons of solid domestic garbage yearly, with a daily generation rate of approximately two and a half kilograms per person. Most solid waste went to landfills, and only a small amount was recycled. This research aims to identify the barriers to implementing waste management strategies in construction projects in Qatar. The questionnaire was used as the primary data collection method and the secondary data were gathered through literature review. It was distributed to around 50 construction professionals, including the client, consultant, main contractor, and subcontractor representatives, using non-probability sampling procedures. According to the final result, 17 barriers were identified in implementing waste management strategies in construction projects in Qatar. "Temporary works" is the most influencing barrier according to an RII value of 0.892 and secondly "Time limit/ Pressure" has shown 0.872 values and thirdly "Rework and unskilled labour" value of 0.852.

Keywords: Gulf Cooperation Council; Waste; Qatar; Management

ICSBE24_310

ASSESSING BUS ROUTE EFFICIENCY USING THE DATA ENVELOPMENT APPROACH: A CASE STUDY IN KANDY DISTRICT

T.G.D.T. Gunasekera*, K.V. Madusanka, W.R.S.S. Dharmarathna, P.M.G.D.M. Herath

Department of Civil Engineering, University of Peradeniya, Peradeniya (20400), Sri Lanka
**Correspondence E-mail: e18121@eng.pdn.ac.lk, TP: +94773799069*

Abstract: The public transport system is critical to the economy and productivity of a country. However, in Sri Lanka, commuters increasingly opt for private transport modes leading to traffic congestion, environmental pollution, and other issues that ultimately affect the country's economy. Bus transport service, one of the primary public transport modes in Sri Lanka, faces numerous challenges, such as overcrowding, lack of safety, reliability issues, poor comfort and inefficient bus route systems. This study focuses on the inefficiency of the bus route system in Kandy district. The objectives of this study are to identify the current origins and destinations of the daily travellers, evaluate the efficiency of the existing bus route system, and propose possible alterations. Data collection involved online and paper-based questionnaire surveys capturing demographic and trip data from regular travellers, and existing bus route data from Sri Lanka Transport Board and Road Passenger Transport Authority. A cross-sectional analysis was conducted to identify significant origins and destinations with high demand. The Data Envelopment Analysis method was used to calculate the efficiency of existing bus routes between high-demand origins and destinations and alterations for the routes were proposed accordingly. The study found that most of the existing routes in Kandy are inefficient, except Kandy–Peradeniya and Kandy – Tennekumbura routes. Alterations to the existing bus system were identified to reduce travel, and transit times to improve the bus route efficiency. The findings suggest that rerouting the buses to less busy, direct routes between high-demand origins and destinations and adjusting bus frequencies can enhance the overall efficiency of the system. Implementing these recommendations promotes public transport and contributes to a more sustainable and efficient transport system in Kandy district

Keywords: Bus Route Efficiency; Public Transport; Data Envelopment Analysis; Economic Impact; Environmental Pollution; Kandy District

ICSBE24_163

ASSESSING TRAFFIC CONDITION DYNAMICS AND THEIR DETERMINANTS: A SPATIAL-TEMPORAL STUDY ALONG THE A04 ROAD, SRI LANKA

G.S.N. Aponsu*, R.M.K. Kumarihamy
Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: senalineth@gmail.com, TP: + 94772823354*

Abstract: Traffic congestion is one of the notable challenges that should be overcome in building a sustainable city. This study uses a positivist approach and geospatial analysis techniques to analyze spatial and temporal variations of the traffic patterns along a 20-km segment of the A04 road from Kottawa to Colombo. Travel data from google maps outscraper, road network data from open street maps, and vehicle count data from Road Development Authority provide an evidence-based framework for examining traffic dynamics. Travel time data were collected for one week from January 01 to January 07, 2023, by applying systematic sampling at segments of 4 km along A04 road, focusing on five key points: Kottawa to Pannipitiya, Pannipitiya to Maharagama, Maharagama to Nugegoda, Nugegoda to Narahenpita, and Narahenpita to Colpetty. Data processing and analysis were conducted by ArcGIS Pro utilizing techniques like dynamic map display and time animation, road density calculation, and calendar heat charts allowing for a comprehensive analysis of the weekly traffic patterns. Key findings revealed that the Nugegoda to Narahenpita section consistently experienced high congestion levels, especially during peak hours from 6:30 am to 7:30 am, as well as in the evening from 5:00 pm to 7:00 pm. Moreover, significantly lower speeds on weekdays compared to weekends demonstrate the impact of daily work and school commutes on traffic congestion. The analysis of road density highlighted that the Western part of the study area, with a higher concentration of roads, experienced more traffic flow, leading to congestion as vehicles converged toward the metropolitan center of Colombo. Also, the increase in several private vehicles accelerates the congestion along the key urban corridors at A04 road. It emphasizes the need for public transport improvement as a sustainable solution to avoid traffic congestion. In conclusion, this study highlights the interplay between traffic levels, road density, and commuter behavior along the A04 road in Sri Lanka and it recommends optimizing public transportation.

Keywords: Traffic Congestion; GIS; Spatial and Temporal Dynamics; Peak Hours

ICSBE24_063

A SYSTEMATIC REVIEW OF ECONOMICAL VISION BASED MODELS FOR TRANSPORTATION SURVEYS IN DEVELOPING COUNTRIES

M. Kulaxia, Nadika Jayasoorya*, A.H.T. Shyam Kularathna
University of Sri Jayewardenepura
**Correspondence E-mail: nadika@sjp.ac.lk, TP: +94774943703*

Abstract: Infrastructure development, traffic management, and urban planning all heavily rely on transportation surveys. Vision based models have the potential to significantly impact road user safety, delay and proper traffic management through the capture and analysis of real-time pictures with depth clues and panoramic views. The study provides a systematic review of vision-based models for transportation surveys with a focus on how they are accepted and suitable in the context of developing countries. The objective is to summarize the level of information on vision-based technologies in order to comprehend the advantages, disadvantages and difficulties associated with their application. Relevant literature was found and assessed using a defined methodology in accordance with predetermined inclusion criteria. The models are compared and contrasted in order to highlight their performance. The results indicate that when it comes to developing countries, due to the heterogenous traffic, aggressive driver behaviour and varying traffic mix, the existing systems become impractical as well as expensive. Therefore, although vision-based models have potential to enhance transportation survey, certain issues need to be considered to customize these technologies to the particular socioeconomic and infrastructure circumstances of developing countries.

Keywords: Vision-based Models; Transportation Economics; Transportation Surveys; Intersection Monitoring

ICSBE24_399

OPTIONS FOR E-MOBILITY IN SRI LANKA

W.N.S. Fernando*, A.S. Kumarage
Department of Transport Management & Logistics Engineering, Faculty of Engineering, University of Moratuwa, Katubedda, Sri Lanka
**Correspondence E-mail: navodansfernando@gmail.com, TP: +94776229474*

Abstract: Sri Lanka's transport sector, with motorcycles and three-wheelers making up 73 % of the fleet, contributes about 50 % of CO_2 emissions. Increased private vehicle ownership, driven by limited public transport investment and low-cost fuel, could reduce public transport share from 50 % to 27 % by 2030. In 2019, the sector consumed 4,027 million litres of fuel, emitting 9.9 million tons of CO_2 equivalent, with private transport contributing 57 %, public transport 12 %, and freight 30 %. Although Sri Lanka is committed to reducing emissions by 14.5 % and transitioning to Electric Vehicles (EVs) by 2040, a clear emissions reduction plan is yet to be formulated. This study explores decarbonization options, drawing insights from global practices like Norway's EV policies, the EU's Green Deal, and India's public transport electrification. The strategies examined include tax incentives, infrastructure development, public transport electrification, and international collaboration. The study identifies three e-mobility intervention options for Sri Lanka's transport sector: Minimal/Do-Nothing, Moderate, and Aggressive. The Minimal/Do-Nothing approach relies on market forces and existing fiscal policies, leading to high energy costs, limited emission reductions, and minimal economic benefits. The Moderate option suggests increased taxes on vehicles and fuel, greater public transport investment, and gradual electrification of buses and railways by 2040, achieving moderate emission reductions and improved economic efficiency. The Aggressive approach, aligned with Sri Lanka's climate-smart strategy, aims for 100 % electric vehicle registrations by 2040, cutting transport emissions by over 50 % by 2040 and 75 % by 2050. It also reduces the annual cost of transport inputs by one-third compared to the Minimal/Do-Nothing option, supporting early economic recovery. These findings highlight the urgent need for Sri Lanka to adopt comprehensive and aggressive policies to decarbonize its transport sector, ensuring sustainable development and alignment with global environmental goals.

Keywords: Sri Lanka; Decarbonizing; Electric Vehicles; Carbon Emission; Public Transport; EV Policy

ICSBE24_308

TRAVEL BEHAVIOUR ANALYSIS OF UNIVERSITY STUDENTS: A CASE STUDY AT UNIVERSITY OF PERADENIYA

P. Tharsika*, W.R.S.S. Dharmarathna
Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka
**Correspondence E-mail: tharsikaprem@gmail.com, TP: +94714203712*

Abstract: Transportation is a significant part in the day-to-day lives of university students. Travel pattern of the university students is unique and complex. Their mode choice decisions vary from common people. Understanding students' travel behaviour is useful to develop efficient transportation systems and sustainable mobility solutions. This study inspects the travel behaviour of the undergraduate students as well as postgraduate students in University of Peradeniya, Sri Lanka. It is the largest suburban university in Sri Lanka with residential accommodation facilities for students and one of the major trip generators in the Kandy region. Additionally, the research examines the factors to develop a sustainable transportation system for university students. For this purpose, raw data (n = 505) was collected using online questionnaire included demographic information and mode-specific information. Cross-sectional analysis was performed around various factors, including the gender, place of residence, per capita monthly income, travel modes, trip purposes, travelling cost and travelling time. From the data analysis, it is found that travelling time and travelling cost are the most dominant factors that determine the mode preferences of students while majority of the trips are educational trips with short travel time. The data also shows a significant variation in travel patterns between on-campus and off-campus residents. Cross-sectional analysis showed that shuttle bus and public bus were mostly preferred by on-campus residents for educational trips whose faculty is situated far away from their hostel while nearby students preferred walking. Motorbike and car were relatively preferred modes by off-campus residents. The study findings will be helpful to understand the university students' travel characteristics and design required sustainable transportation planning policies.

Keywords: Travel Behaviour; Mode Choice; University Students; Sustainable Transportation

ICSBE24_309

TRAVEL BEHAVIOR CHANGES UNDER FUEL PRICE FLUCTUATIONS: A CASE STUDY IN SRI LANKA

R.K.K.M. Bandara*, K.A.B.P. Rathnaweera , W.R.S.S. Dharmarathna
Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: kavindyabandara100@gmail.com, TP: +94702903688*

Abstract: Over the past two decades, Sri Lanka has experienced significant fuel price fluctuations, with sharp increases in recent years. This study investigates how individuals adapt their travel habits in response to these shifts amid Sri Lanka's economic situation. The impact of fuel prices on travel behaviour has been understudied in the literature. Researchers employed various quantitative techniques, including simultaneous equations, cross-sectional analysis, elasticity estimations, time series analysis, panel data models, and regression models, to understand this complex relationship. This study analysed Sri Lankans' travel patterns before and after the significant fuel price changes in late 2021, using data collected through a questionnaire survey. Recognizing the complexity of this matter, research focused on mode choice variation due to fuel price fluctuations through cross sectional and regression analysis to explore the theoretical relationship between mode change and influencing independent variables. The work reveals that fuel price fluctuations significantly influence travel mode selection. Lower-income groups heavily rely on public transport for daily trips and show slight mode shifts regardless of fuel prices. In contrast, higher-income private vehicle users demonstrated a greater propensity to switch their modes based on fuel costs. Fuel price hikes have encouraged a shift towards public transport, while a considerable segment remains reluctant to change modes, highlighting the complex interplay of factors beyond fuel costs in their travel decisions. The results highlight the necessity of a comprehensive transport policy that encourages the use of public transport and non-motorized modes like cycling, regardless of fuel price volatility, which will contribute to long-term sustainable urban mobility in Sri Lanka.

Keywords: Fuel Price Fluctuations; Travel Behavior; Mode Change; Public Transportation; Sustainable Mobility

ICSBE24_300

GREEN HOUSE GAS EMISSION OF ASPHALT PAVEMENT CONSTRUCTION IN SRI LANKA

B.K.D. Balasuriya*
Sri Lanka Institute of Advanced Technological Education (SLIATE), No 42, Rodrigo Place, Mattakkuliya , Colombo 15, Sri Lanka
**Correspondence E-mail: kumudubalasuriya@sliate.ac.lk, TP: +94716841028*

Abstract: The construction of roads has caused adverse effects on the environment, with one of the major issues being the greenhouse gases (GHG) emission. The objective of this research study were to estimate the GHG emissions related to the construction of asphalt pavements in Sri Lanka and recommend appropriate strategies in mitigating GHG emission of road construction practices. The scope of the study was limited, only to the sources of GHG emissions in the production stage, material transport stage, and construction stage. A Life Cycle Assessment (LCA) was conducted to quantify GHG emissions for selected life cycle stages of four asphalt pavements (flexible pavements) across various regions of Sri Lanka. To facilitate comparison, the functional unit was defined as the GHG emission per 1 kilometer length of a lane with a width of 3.5 meters. The majority of GHG emissions were linked to asphalt production and aggregate production, accounting for more than 80 % of the total GHG emissions during the production stage. The average aggregate transport GHG emissions exceeded those of the other materials, contributing to 65.2 % of the total transport GHG emissions. The primary factor influencing GHG emissions at the transport stage was the amount of materials and the distance they were transported. The average of GHG emission of production stage, transport stage and construction stage are 81.9 %, 12.4 % and 5.6 % respectively. The total GHG emission to the functional unit was determined to be 46,523.75 $kgCO_{2eq}$ at the construction stages of asphalt pavement. By improving the efficiency of fuel usage of machineries and vehicles adopting the latest engine technologies or utilizing alternative fuels can contribute to GHG emissions reduction efforts. By adopting the optimal design at the design stage, the material quantity required for the functional unit can be reduced.

Keywords: GHG Emission; Asphalt Pavement; Life Cycle Assessment; Functional Unit

ICSBE24_301

ESTIMATION OF PASSENGER CAR EQUIVALENT FOR SELECTED EXPRESSWAYS IN SRI LANKA

K.V.D. Perera*, W.R.S.S. Dharmarathna
Department of Civil Engineering, University of Peradeniya
**Correspondence E-mail: vperera1989@eng.pdn.ac.lk, TP: +94716903108*

Abstract: The road traffic systems, travel patterns, vehicle, and driver characteristics are different from country to country due to changes in geometric patterns of a country, available transport facilities for road users, and rate of development in the transport sector. Therefore, it is essential to consider different traffic parameters for different regions since many standards related to traffic engineering are specific to different regions. Passenger Car Equivalent (PCE) or Passenger Car Unit (PCU) values in different vehicle categories vary with many factors such as vehicle characteristics, climatic conditions and traffic flow characteristics. Many PCE related studies have been carried out in the past all around the world based on highways. In Sri Lankan context, few researches were being carried out about PCE evaluation, but hardly found research on PCE evaluation under expressway category. This paper is based on evaluation of PCE on Sri Lankan expressways; Southern (E01), Outer Circular (E02), and Katunayake (E03) expressways. This study used Chandra's method to calculate PCE values for eight vehicle categories. The vehicle dimension data were collected through the literature and field measurements. The observed speed values of vehicles were obtained by considering vehicle entry and exit time for a fixed length in each expressway. Accuracy of calculated and simulated speed values were checked using several statistical methods including R-Squared method after simulation of results through PTV VISSIM software.

Keywords: Passenger Car Equivalent (PCE); Chandra's Method; VISSIM; Expressway Design; Sustainable Transport

ICSBE24_822

A LAND USE CLASSIFICATION METHOD FOR A CELLUAR AUTOMATA BASED LAND USE PREDICTION MODEL

K.D. Herath[1*], P.C.P. De Silva[2], P.K.S. Mahanama[2]
[1]Postgraduate Research Student, University of Moratuwa, Katubedda, Sri Lanka
[2]University of Moratuwa, Katubedda, Sri Lanka
**Correspondence E-mail: kanakadh@gmail.com, TP: +94773208869*

Abstract: A variety of land use prediction models can be observed elsewhere in the world, and they are doing a tremendous job in the planning its allied disciplines. But still it has been a distant factor in Sri Lanka. Unlike other models, cellular automata-based models are highly depending on the land cover data in past and present. But land cover data are developed by many government and private agencies with a range of objectives, and they are based on different classification schemes and have discrepancies (Mushtaq et al, 2022). Missing of a standard land use classification method has created a situation that all available land cover data and their applications have many limitations. Further, an analysis of cellular automata-based land use models shows that the accuracy increases as the heterogeneity of land use increases (PEI et al). Here, a standard land use classification method was developed considering many parameters such as availability, accuracy, informative, acceptability, validity and affordability. Land use legends from existing research articles, planning regulations and reports, project reports, published maps, satellite images, big data, etc, were thoroughly evaluated here. Further, a numerical analysis was carried out to showcase the existence level of each land use category at present.

Keywords: Land Use; Classification; Model; Cellular Automata

ICSBE24_017

URBAN TRANSPORT FOR ACHIEVING HUMAN SATISFACTION AND HOLISTIC SUSTAINABLE DEVELOPMENT IN SRI LANKA

J.A.C.D. Jayalath[1*], J.A.G.R. Jayalath[2], J.A.S.K. Jayalath[3]
[1]Hyundai Engineering & Construction, Colombo, Western, Sri Lanka
[2]Resources Development Consultants, Colombo, Western, Sri Lanka
[3]Grabner huber lipp, Hamburg, Germany
**Correspondence E-mail: charuka960808@gmail.com, TP: +94705029337*

Abstract: The pursuit of sustainable development involves integrating subjective goals, such as human happiness and satisfaction, together with already established objectives like environmental, economic, and social well-being. Sri Lanka, a nation historically entrenched in a traditional development approach, has grappled with economic crises stemming from unsustainable investment policies and debt. The government faces a critical challenge to invest optimally, necessitating the adoption of a unique holistic approach to sustainable development that integrates both subjective and objective goals. This approach seeks to optimize returns from developmental initiatives while safeguarding the mental and spiritual well-being of its citizens. This study focuses specifically on the urban transport sector, which significantly affects citizens' daily lives, their time, cost, and overall activities. Additionally, it has a major impact on the economy and is a significant contributor to greenhouse gas emissions and other pollutants. The research utilizes literature surveys and quantitative analyses from primary and secondary sources. The paper's findings highlight the conditions that impact human well-being with reference to accepted philosophies related to mental well-being and the relationship of both subjective & objective goals with the urban transport sector. The study's findings highlight the inadequacies of current transport and city development strategies in comprehensively addressing both subjective and objective sustainable development goals within the transport sector. Notably, the research underscores the potential efficacy of prioritizing investments in public transport infrastructure, rectifying existing failures, and fostering human-centered approaches to urban development. These strategies are identified as an avenue for achieving a harmonious balance between subjective well-being and overarching environmental, social, economic & cultural sustainability objectives.

Keywords: Sustainable Development; Mental Well-being; Economy; Transport

ICSBE24_033

ASSESSMENT OF PHYSICAL AND MECHANICAL PROPERTIES OF PAVING BLOCKS MADE USING USED CLAY ROOF TILES AS CHIP AGGREGATE

K.Derikshan, R.A.N. Dilrukshi*
Department of Construction Technology, Faculty of Technology, Wayamba University of Sri Lanka,
Kanadulla, Kuliyapitiya, Sri Lanka.
** Correspondence E-mail: dilrukshi@wyb.ac.lk, TP: +94716434803*

Abstract: Sustainable concrete production using waste materials is gaining popularity. Globally, the construction industry heavily relies on concrete, which contains a higher volume of aggregates than cement. This extensive use leads to the depletion of natural aggregates. To address this issue, recycled aggregates can be used as a viable alternative. Demolition waste, which includes various materials such as concrete, bricks, wood, steel, glass, roof tile, etc. is abundant worldwide. Among these, roof tiles are one of the significant components of demolition debris in Sri Lanka. In the present study, the used clay roof tile chip aggregate (RTCA) was used for casting paving blocks measuring 200 mm × 100 mm × 60 mm with added percentages of used RTCA by 10 %, 25 %, 50%, 75 %, and 100 % and tested for compressive strength after 7 days and 28 days of curing, as well as for water absorption. The DOE method of mix design was used for calculating the mix proportions, resulting in a zero slump up to 50% used RTCA added mixture. Additionally, an increase in the W/C ratio was obtained with the higher percentage of used RTCA. The result shows that there is a possibility to maintain required compressive strength of paving blocks for strength class 4 of SLS 1425 Part 1:2011 by adding used RTCA up to 75% in order to use them for pedestrian use strictly excluding any vehicle access as specified in SLS 1425 Part 1:2011. Further, as the high-water absorption of paving blocks made using used RTCA, there is a possibility to use them in high rain fall and saturated environments or use to avoid the accumulation of water on the surface of the platforms or foot paths.

Keywords: Demolition waste; Used clay roof tile chip aggregate; Paving blocks; Compressive strength; Water absorption

ICSBE24_042

INCORPORATING INDUSTRIAL WASTE INTO SUSTAINABLE BACKFILL MATERIAL

P Suloshini*
University of Jaffna, Sri Lanka.
**Correspondence E-mail: suloshini@eng.jfn.ac.lk, TP: +94778842520*

Abstract: The integration of industrial waste in civil engineering projects has gained considerable attention due to its potential in promoting sustainability and reducing environmental impact. This study investigates the feasibility and benefits of incorporating fly ash and bottom ash into sustainable backfill material. Traditionally, fly ash and bottom ash have posed significant disposal challenges, occupying extensive landfill space and groundwater contamination. Bottom ash, characterized by its coarse texture, provides excellent drainage and compaction properties, while fly ash, finer and more pozzolanic, enhances the mechanical strength and durability. When combined, these two materials offer a synergistic effect that can substitute conventional backfill material. In addition to that, the environmental benefits are substantial. Utilizing these industrial by-products reduces the need for natural resource extraction, minimizes waste disposal issues, and lowers the carbon footprint associated with material transportation. Furthermore, the adoption of these sustainable practices aligns with regulatory trends and green building standards, promoting eco-friendly construction methods. A series of laboratory experiments were conducted to find the optimal mix proportions of fly ash and bottom ash to achieve desired geotechnical properties including index properties, compaction, permeability, shear strength and compressibility. According to results, increased fly ash content improved maximum dry density, compressibility characteristics while permeability and shear strength are enhanced by the bottom ash content. By considering the results and economic benefits, it can be concluded that, fly ash:bottom ash ratio of 40:60 could satisfy the requirements of backfill material. In conclusion, the incorporation of bottom ash and fly ash into sustainable backfill material presents a viable and advantageous solution for civil engineering projects. This approach not only enhances the performance and sustainability of construction practices but also addresses environmental and economic challenges.

Keywords: Bottom Ash; Compaction; Fly Ash; Shear Strength; Sustainability

ICSBE24_109

MECHANICAL PROPERTIES OF ALTERNATIVE MATERIAL CONCRETE: A HOLISTIC REVIEW

Yehan S. Rajapakse [1*], Kavishka Gunarathna [2], Shayani Mendis [2]
[1]School of Engineering and Technology, The University of New South Wales, Canberra, ACT 2600, Australia.
[2]Department of Civil Engineering, Faculty of Engineering, General Sir John Kotelawala Defence University, Ratmalana 10390, Sri Lanka.
**Correspondence E-mail: y.rajapakse@unsw.edu.au, TP: +94 716844698*

Abstract: The use of concrete has undergone an exponential growth worldwide, making it one of the most widely used man-made materials in the world, ultimately raising issues in sustainability. These concerns have led researchers to examine the performance of various types of alternative materials replacing different constituents in concrete including fine aggregate, coarse aggregate and cement. This study provides a holistic review on the state-of-the-art of alternative material concrete along with a quantitative comparison among the proposed alternative materials under mechanical properties. In accordance with the review, electric arc furnace slag could be recommended as a promising coarse aggregate replacement under both compressive strength and tensile strength. Moreover, blast furnace slag as a coarse aggregate replacement and coal bottom ash as a fine aggregate replacement (only up to 80%) could be recommended in applications where flexural strength and modulus of elasticity predominate respectively.

Keywords: Alternative Materials; Mechanical Properties; Sustainable Concrete; Fine Aggregate; Coarse Aggregate; Cement

ICSBE24_106

SOIL IMPROVEMENT USING CALCIUM PHOSPHATE CEMENT DERIVED FROM BONE WASTE

A. Insaf Ahameth[1], S. Niruparan[1], S. Jathursan[1], S. Venuja[1]*, S. Gowthaman[2], T. H. K. Nawarathna[1]

[1]Department of Engineering Technology, Faculty of Technology, University of Jaffna, Kilinochchi, Sri Lanka

[2]Faculty of Engineering, Kyushu University, Fukuoka, Japan

**Correspondence E-mail: venuja@tech.jfn.ac.lk, TP: +94771751337*

Abstract: Bio-cementation using the enzyme-induced carbonate precipitation (EICP) process is a modern and innovative soil improvement technique. However, a major issue with current EICP methods is the release of gaseous ammonia, which pollutes the air, and ammonium ions, which contaminate groundwater during urea hydrolysis. This research proposes an alternative approach using waste bone powder to induce Calcium phosphate precipitation through enzymatic hydrolysis of urease. Bone is a low-cost and viable resource, offering a more sustainable solution to soil stabilization. In the study, acid-dissolved cow-bone waste was injected into sand columns along with urea and acid urease. The enzymatic hydrolysis of urea led to an increase in the pH of the reaction medium, facilitating the precipitation of Calcium phosphate within the pore spaces, thereby cementing the soil particles. Various tests were conducted to evaluate the impact of urea content and grain size distribution on cementation efficiency. Results indicated that higher urea content enhanced the reaction extent, while a decrease in grain size distribution reduced cementation efficacy. Cementation was effectively achieved to a depth of 6 cm with grain sizes between 425 µm and 600 µm. Scanning Electron Microscopy (SEM) analysis revealed the formation of plate-like crystals, which formed cementation bridges between adjacent soil particles. This proposed method is a sustainable approach with significant economic and ecological benefits. It offers a potential pathway for the reuse of bone waste in geotechnical practices, thereby reducing waste generation. Additionally, the use of waste materials makes the method cost-effective and more feasible for real-scale applications in Sri Lanka.

Keywords: Bio-cementation; Bone Waste; Soil Stabilization; Enzymatic Hydrolysis of Urea; Calcium Phosphate; Cementation Efficiency

ICSBE24_183

GRADING SRI LANKAN BAMBOO SUBJECTED TO TENSILE LOADS

S.A.S. Madhushan [1*], H.A.D.S. Buddika [1], S. Bandara [1], , N.Abeysuriya [2]
[1]Faculty of Engineering, University of Peradeniya, Peradeniya, 20400 Sri Lanka
[2] NCD Consultants (Pvt) Ltd, Sri Lanka
**Correspondence E-mail: sumeeramadhushan96@eng.pdn.ac.lk, TP: +94702130249*

Abstract: The use of bamboo in modern construction has become more popular in recent years due to its environmental friendliness, fast growth, and unique mechanical performance. Most of the bamboo species have higher mechanical properties compared to commercial softwood species and one of the key attributes of bamboo is its higher strength to weight ratio. In order to utilize this sustainable construction material, it is essential to study its mechanical performance and grade it appropriately. This study is about developing proper grading and creating structural quality classes for *dendrocalumus gigentious* (giant bamboo) under axial tensile loading parallel to the fibre direction. A comprehensive experimental series was conducted to investigate the correlation between tensile capacity of bamboo with its geometric and material properties. It was observed that the tensile capacity prediction is more reliable than the strength estimation and the cross-sectional area of the bamboo was identified as the best predictor to determine the tensile capacity parallel to the fiber direction. The linear regression analysis formulates the relationship between the indicating properties and the tensile capacity. Moreover, the categorized structural quality classes can be utilized to identify the characteristic values of the tensile capacity and strength of bamboo in construction applications.

Keywords: Bamboo; Tensile Testing; Structural Grading; Sustainable Construction Materials; Mechanical Properties

ICSBE24_157

THE EFFECT OF BORON TREATMENT ON SELECTED PINE WOOD SECTIONS USING THE DIP DIFFUSION METHOD

C.K. Muthumala*, W.V.T.D. Amarasinghe, C. Madusanka
State Timber Corporation, Sri Lanka
**Correspondence E-mail: ck_muthumala@yahoo.com, TP: +94777834716*

Abstract: Pinewood species are major softwood species in Sri Lanka; it is expected to increase annual harvesting volume in the near future. Thus, the local pinewood market has to be expanded, nevertheless, less durability of untreated pinewood is the major obstacle to their maximum utilization. Therefore, pinewood preservation is vital; the boron treatment is an effective method to increase the durability of pinewood, which is a mixture of Boric acid and Borax. Moreover, the pressure impregnation treatment method is more costly; hence, small-scale wood industries and household consumers mostly use the dip diffusion method. This study aims to investigate the effect of boron treatment by dip diffusion on selected pinewood sections: 19 mm*150 mm, 25 mm*150 mm, 31 mm*150 mm, 50 mm*50 mm and 50 mm*100 mm. All sections were immersed in 38 % boron solution for four diffusion periods: 6 hours, 12 hours, 24 hours and 48 hours. At ending of each period, the sections were cut at the halfway point of each wood piece and the Turmeric treatment was applied to determine the penetration of the boron of the sections. Penetration depth of studied sections was grouped into four categories No absorption or N (No colour change), Low or L (<= 3 mm), Medium or M (4-6 mm), High or H (>6 mm). Conclusions are; 06 hours diffusion is appropriate for sections 19 mm*150 mm and 24 hours diffusion is appropriate for sections 25 mm*150 m and 31 mm*150 mm. 50 mm*50 mm section is required at least 48 hours for full penetration. The tested time duration periods are not adequate for Sections 50 mm*100 mm for full penetration.

Keywords: Pinewood; Boron; Dip-diffusion; Time

ICSBE24_074

FLEXURAL RESPONSE OF COCONUT FIBRE REINFORCED MORTAR UNDER VARYING LOADS

L.H.G. Lamahewa[1], H.M.C.C. Somarathna[1,2*], O.K. Surasinghe[1], K.G.K.D. Samarakoon[1]

[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka

[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka

**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: Mortar is a commonly used construction material in construction due to its higher compressive strength. But it is weak under flexural stresses. As a result, cement mortar is susceptible to damage under dynamic loads with various strain rates. These circumstances can create threats to human life and property. However, current methods of strengthening masonry are mostly inadequate to absorb energy during dynamic loadings and are neither readily available nor economically feasible. In this research, Coconut Fibre Reinforced Mortar (CFRM) specimens are subjected to various out-of-plane dynamic loading conditions and investigated for variations of fibre lengths with specific fibre content by conducting the three-point bending test using a Universal Testing Machine (UTM) under cross-head speeds of 0.5, 10 and 200 mm/min to simulate quasi-static to impact loading conditions. The findings demonstrated that, under dynamic loading, CFRM showed significant improvements in stresses, strains and energy absorption for all conditions. Extending the fibre length from 15 mm to 25 mm led to a significant increase in maximum stresses and maximum strains at maximum stresses, underscoring the influence of fibre length on the flexural properties of the material.

Keywords: Coconut Fibre Reinforced Mortar; Varying Load; Flexural Response; Sustainability

ICSBE24_494

PROMOTING SUSTAINABILITY BY IMPLEMENTING "OL-ID" SYSTEM FOR THE HEALTHCARE INDUSTRY

W.M.M.A. Abeyarathna*, W.M.H.M. Aththanayake, Roshani faleel, R.M.A.U. Rathnayaka, K.C.S. Ekanayake
International College of Business and Technology,
No: 365, D.S. Senanayake Street, Kandy
**Corresponding E-mail: methmiabe2000@gmail.com, TP: +94702966819*

Abstract: Insufficient safeguarding of patient health information provides significant challenges in the medical field, increasing patient care and data administration more difficult. To address these important challenges by improving sustainability, this research proposes "OL-ID" (All in One Simple Card), a novel medical data access system that combines Internet of Things (IoT) and Radio Frequency Identification (RFID) technology. The principal objectives of the project are to determine and repair the weaknesses in the current medical data systems while integrating sustainability into every aspect of the systems' construction and functioning. The research emphasizes the productive implementation of a desktop program and a small hardware circuit for effective data registration and management while reducing power consumption, integration costs, and maintenance costs. The environmental impact of traditional paper-based record-keeping is significantly reduced by the OL-ID system, despite a significant value on sustainability. Resource efficiency is benefited by the strategy by reducing waste and paper usage. The hardware's small size and innovative design encourage sustainability by utilizing less material. In addition, the OL-ID system's control over lifetime personal records lessens the requirement for duplicate data, enhancing operational effectiveness and encouraging sustainable practices in a variety of sectors, such as banking, law enforcement, healthcare, and education. Furthermore, the OL-ID approach focuses an intense focus on sustainability, taking into account social and economic factors in addition to environmental ones. The technology contributes to the long-term resilience and sustainability of Sri Lanka's healthcare sector and other critical industries by enhancing the security and efficiency of medical data administration. As a result, the OL-ID system presents a transformative and long-term solution to the problems facing medical data management currently. It has the potential to greatly improve patient outcomes and operational effectiveness in a variety of sectors.

Keywords: Sustainable Management; Operational Efficiency; Healthcare Innovation; Internet of Things

ICSBE24_184

UTILIZATION OF CONSTRUCTION AND DEMOLITION WASTE AS A REPLACEMENT FOR NATURAL SAND IN MORTAR

H.G.T. Ravishka*, C. Jayasinghe, I.E. Ariyaratne
Department of Civil Engineering, University of Moratuwa.
**Correspondence E-mail: ravishkathanula@gmail.com, TP: +94774232106*

Abstract: The depletion of natural aggregates and the growing accumulation of Construction and Demolition (C&D) waste have raised concerns regarding environmental sustainability in the construction industry. This study addresses the dual problem of sand scarcity and waste disposal by investigating the feasibility of using C&D waste as a partial replacement for natural sand in mortar production. Mortar mixes with sand replacement levels of 0%,10%, 20%, 30%, 40%, and 50% by weight were prepared and evaluated for workability, and compressive strength. The experimental program included particle size distribution analysis of C&D waste and river sand, followed by standard flow table tests to maintain consistent workability. Adjustments to the water-to-cement (w/c) ratio were made to achieve a flow diameter of 175 ± 10 mm. Compressive strength tests were performed on mortar cubes at 7 and 28 days to assess mechanical characteristics. Results indicated that the with the amount of replacement of C&D waste, the lower the workability, which necessitates a higher water-to-cement (w/c) ratio at high replacement levels. Nevertheless, all mixes exceeded the standard compressive strength requirement of 4 MPa for a 1:5 mortar mix, even at the 50% sand replacement level. These findings demonstrate that C&D waste can effectively replace natural sand in mortar production without compromising the compressive strength, offering a sustainable solution for reducing reliance on natural resources, while addressing waste management challenges. The study highlights the potential of C&D waste as a viable alternative in the construction industry, fostering environmental conservation and promoting sustainable construction practices.

Keywords: Construction and Demolition Waste; Alternative Materials; Waste Management; Mortar

ICSBE24_118

TENSILE RESPONSE OF COCONUT FIBRE REINFORCED MORTAR UNDER VARYING LOADS

O.K. Surasinghe[1], H.M.C.C. Somarathna[1,2*], L.H.G. Lamahewa[1], K.G.K.D. Samarakoon[1]

[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka

[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka

**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: The incorporation of coconut fibre into traditional mortar has emerged as a viable and eco-friendly method for improving its inherently weak tensile strength. The susceptibility of cementitious mortar composites to abrupt and significant damage when subjected to dynamic loads significantly risks human lives and property. Moreover, the majority of current methods of fibre-reinforced masonry structures offer limited insights into their behaviour under various dynamic loading scenarios. This study focused on assessing the dynamic tensile response of Coconut Fibre Reinforced Mortar (CFRM) specimens under different dynamic loading conditions. The evaluation involved CFRM samples with two distinct fibre lengths, undergoing splitting tensile tests at varying cross-head speeds (0.5, 10, and 200 mm/min) to simulate quasi-static and low-impact dynamic conditions. This approach facilitated an analysis of the correlation between stress, strain, and energy absorption under these conditions. It was observed that the maximum stress experienced by the specimens increased with the severity of the loading condition, coupled with a decrease in the strain at peak stress. The variation in cumulative energy absorption across the loading conditions did not follow a consistent trend. Importantly, extending the fibre length from 15 mm to 25 mm significantly enhanced the maximum stress and associated strains, underscoring the influence of fibre length on the tensile characteristics of the material. These insights are vital for the development of safer building and infrastructure designs, while also advancing the use of sustainable construction materials.

Keywords: Coconut Fibre Reinforced Mortar; Varying Load; Tensile Response; Sustainability

ICSBE24_993

EVALUATING THE EFFECTS OF RUBBER PARTICLE SOURCE AND SHAPE ON THE MECHANICAL PROPERTIES OF AQUA-THERMALLY TREATED RUBBERIZED CONCRETE

B.G.V. Sanjaya[1,2*], J.M.R.S. Appuhamy[2], W.M.K.R.T.W. Bandara[2], S. Venkatesan[1], R.J. Gravina[1,3]

[1]School of Engineering, RMIT University, Melbourne, Australia
[2]Faculty of Engineering, University of Ruhuna, Galle, Sri Lanka
[3]School of Civil Engineering, The University of Queensland, St Lucia, Australia
**Correspondence E-mail: S3959393@student.rmit.edu.au, TP: +94714771808*

Abstract: The inherent strength losses in rubberized concrete emphasize the need for pre-treatment of rubber particles before their incorporation into concrete. Existing literature has explored various chemical, physical and combined treatment methods. The influence of these treatment methods on concrete performance varied, with some resulting in improvement, others in reduction and some having negligible impact. Additionally, some studies have reported that the effort and cost associated with certain treatments do not justify the performance gain. To address these challenges, a new method called the aqua-thermal treatment method was implemented. This approach combines water-based and heat treatment to produce relatively stiffer rubber aggregates by eliminating most impurities and textile particles adhered to the raw rubber. This formation established a stronger bond at the rubber/cement interface, thereby enhancing the mechanical performance of concrete. Subsequently, these findings suggest the potential of utilizing rubberized concrete in structural applications. However, the source, sizes and shape of the rubber particles can also influence the effectiveness of the treatment method. This underscores the need for further investigation into aqua-thermally treated rubberized concrete. Hence, this study evaluated the impact of particle size and shape on the mechanical performance of aqua-thermally treated rubberized concrete sourced from three different origins. The findings from this investigation revealed a slight variation in compressive strength, while flexural strength remained mostly unchanged across different rubber sources. Notably, the workability of concrete was significantly affected by irregular rubber particles. Overall, well-graded rubber particles demonstrated optimal workability and enhanced mechanical performance, underscoring the effectiveness of the proposed method.

Keywords: Aqua-thermal Treatment; Rubberized Concrete; Strength Recovery; Crumb Rubber; Particle Sizes

ICSBE24_076

PROCESSING LIPSTICKS FROM SRI LANKAN NATURAL RESOURCES: LITERATURE REVIEW

W.M.P.K.K. Walgampaya, C.S. Kalpage*
University of Peradeniya
**Correspondence E-mail: csk@eng.pdn.ac.lk, TP: +94773715098*

Abstract: Cosmetics cover a wide range of products designed to enhance, clean, or alter various aspects of personal appearance, including skin, hair, nails, and teeth. These are beauty preparations and grooming aids made of chemical compounds, either synthesized or derived from natural ingredients. Indeed, some cosmetic products contain heavy metals, which are very toxic and persistent in ecosystems and may build up over time, leading to health and environmental effects. Some of the synthetic compounds may have risks, so it becomes very essential to make a foray into the development of cosmetics based on natural ingredients for their preparation. Several advantages of natural cosmetics include lesser health risks, good quality, and suitability for different types of bodies. The objectives are to classify cosmetics according to use, to relate properties of cosmetics with their chemical constituents, to choose the most demanding cosmetic group and describe processing methods, to compare characteristics of chemically synthesized and naturally extracted cosmetics, and to assess the potential of making natural resource derived cosmetics in Sri Lanka for the world market. This paper examines how beetroot and carrot can be used as components in lipstick formulation. This study shows the possibility of using beeswax, beetroot, and carrot which are from Sri Lanka itself for the production of natural lipsticks.

Keywords: Beetroot; Carrot; Beeswax; Cosmetics; Natural

ICSBE24_002

ASSESSMENT OF MECHANICAL PROPERTIES OF *Eucalyptus* SPECIES IN SRI LANKA

C.K. Muthumala[1*], K.K.I.U. Arunakumara[2]
[1]*Research, Development and Training Division, State Timber Corporation, Sri Lanka*
[2]*Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Sri Lanka*
**Correspondence E-mail: ck_muthumala@yahoo.com TP: +94777834716*

Abstract: *Eucalyptus* is a diverse genus of trees in the family of Myrtaceae. Many *Eucalyptus* species are employed in producing timbers in different parts of the world. However, due to the lack of information on the mechanical properties of different *Eucalyptus* species, commercial applications of them are hindered. In the present research, nine *Eucalyptus* species grown in Sri Lanka namely: *E. camaldulensis, E. citriodora, E. torelliana, E. pilularis, E. tereticornis, E. globulus, E. microcorys, E. robusta* and *E. grandis* were employed in the determination of the mechanical properties for distinguishing the species. Values of Modulus of Rupture (MOR), Modulus of Elasticity (MOE) and Compression parallel to grain were calculated following the BS 373:1957 standards (1999). *E. citridora* showed the highest strength properties while *E. toraliyana* exhibited the least strength properties. Positive relationships among the wood density values and mechanical properties of different of *Eucalyptus* species were observed.

Keywords: *Eucalyptus*; Mechanical Properties; Density

ICSBE24_795

COMPRESSIVE RESPONSE OF COCONUT FIBRE REINFORCED MORTAR UNDER VARYING LOADS

K.G.K.D. Samarakoon[1], H.M.C.C. Somarathna[1,2*], L.H.G. Lamahewa[1], O.K. Surasinghe[1]

[1]Department of Civil Engineering, Faculty of Engineering, University of Jaffna, Ariviyal Nagar, Killinochchi 44000, Sri Lanka

[2]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka

**Correspondence E-mail: hmccsomarathna@gmail.com, TP: +94718304634*

Abstract: Incorporating coconut fibre into traditional mortar has been identified as a viable technique for enhancing its compressive performance, thereby presenting an engineering solution for improved waste management. The superior performance of Coconut Fibre Reinforced Mortar (CFRM) can be attributed to the inherent properties of coconut fibre, which include enhanced thermal resistance, high toughness, ductility, and durability. Additionally, coconut fibre is a renewable and cost-effective material. Current studies for analysing fibre-reinforced masonry structures offer a limited perspective on their behaviour under various loading conditions, such as seismic, low-impact, and high-impact forces. This research investigates the dynamic compressive behaviour of CFRM specimens under diverse dynamic loading conditions. The study specifically examines CFRM samples incorporating fibres of two different lengths (15 mm to 25 mm) and evaluates their compression strength through tests conducted using a universal testing machine at cross-head speeds of 0.5, 10, and 200 mm/min. These speeds were chosen to simulate a range of loading conditions from quasi-static to low-impact. The analysis focused on understanding the relationships between stress, strain, and energy absorption under these conditions. The findings indicate an improvement in compression strength and a reduction in both strain and strain energy at peak stress with an increase in strain rate. The strength and strain at peak stress exhibited gradual changes with the strain rate. Moreover, the cumulative energy absorption demonstrated variable trends across different loading conditions. Importantly, the inclusion of coconut fibre in the mortar significantly enhanced its resistance to crack propagation across all considered loading scenarios, suggesting that CFRM could be a sustainable alternative to traditional mortar, especially in structures susceptible to seismic and low-impact loads.

Keywords: Coconut Fibre Reinforced Mortar; Varying Load; Compressive Response; Sustainability

ICSBE24_120

TRACING THE TRANSFORMATION: RECONSTRUCTING THE ANCIENT KANDYAN LANDSCAPE

W.M.S.S. Dias[1*]
University of Peradeniya, Peradeniya, Sri Lanka
**Correspondence E-mail: mihirdias@gmail.com, TP: +94779414936*

Abstract: Kandy, designated as a UNESCO World Heritage city, has long sought to preserve its historical character. However, significant transformations in Kandy occurred between the 1810s and 1900s, influenced by both the rule of the Kandyan Kingdom and the British colonial administration. This study aims to map these transformations across specific historical periods with Geographic Information System (GIS) and to compare the ancient landscape with contemporary views from vantage points. Secondary data sources, including historical maps, landscape photographs, and archival records were used to reconstruct the historical Kandyan landscape and identify the causes of the transformations. Primary data were collected through field observations from city viewpoints, facilitating a comparative analysis between past and present scenic views. Data analysis involved georeferencing and manual digitisation for preparing historical maps, while 3D mapping within ArcGIS, and historical contextual analysis. The results highlight the delineation of the Kandyan landscape through three distinct periods: the pre-1810 era, before the construction of the *Kiri Muhuda* (present Kandy Lake), during which the area functioned as a paddy field known as Thingol Vela; the post-1815 period, following the creation of Kandy Lake by King Sri Vikrama Rajasinha, marked by modifications such as the construction of the Paththirippuwa (octagonal pavilion) and the protective wall; and the late 19th century, when British administrative altered the landscape by filling the Old Bogambara Lake and constructing military installations alongside Anglican churches near prominent Buddhist temples, including Dalada Maligawa. Furthermore, the study reveals that while some attractive viewpoints, such as Wales Park (southwest) and Lady Horton Walk (east), have diminished visibility due to increased tree cover, others have remained largely intact, with the street layout of the city preserving its configuration from the Kandyan Kingdom era. Illustrating, beneath the quiet of Kandy lies a landscape intertwined with a complex history of transformation.

Keywords: Kandyan Landscape; Historical Transformation; Geographic Information Systems; Historical Mapping

ICSBE24_611

RAINWATER HARVESTING AS AN URBAN PLANNING STRATEGY IN PINGA OYA IN AKURANA, SRI LANKA

D.M.L. Dissanayake, M.H.S. De Silva*
Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: mithmadesilva97@gmail.com, TP: +9476 694 7607*

Abstract: Akurana, an unplanned town in Sri Lanka's Kandy District, is facing rapid urbanization and frequent flooding, posing risks to both infrastructure and residents. Since the 1980s, urban growth has replaced the town's perennial croplands with built-up areas, increasing surface runoff and reducing water infiltration during heavy rainfall, which contributes to flooding. This study proposes a sustainable urban development strategy for Akurana, based on the Green Built Environment concept and aligned with Sustainable Development Goal 11. The strategy integrates flood mitigation with eco-friendly urban growth through urban-scale Rain Water Harvesting (RWH) systems to manage stormwater and reduce flood risks. The primary objective of this study is to design a system that delays excess runoff, helping to control stormwater and reduce flooding in the Pinga Oya Micro Catchment Area in Akurana. Geographic Information System (GIS) methods and satellite data will be used to digitize roof coverage in the study area. The potential for rainwater harvesting will be calculated using the equation: RWH potential = C * I * Ar. Here, C is the runoff coefficient (ranging from 0.5 to 0.9 based on roof material and slope), I is the average rainfall in millimeters, and Ar is the roof area in square meters. This approach will estimate the total rainwater retention capacity through RWH tanks, which will be compared to the total rainfall in the area. Field surveys, interviews, observations, as well as rainfall data, housing statistics and other secondary sources will further verify these estimates. The study anticipates that increased water retention through RWH tanks will significantly reduce surface runoff and delay the flow of excess water into Pinga Oya, mitigating flood risks. Akurana's RWH strategy could serve as a model for other Sri Lankan towns facing similar challenges, reducing the country's vulnerability to natural disasters.

Keywords: Rainwater Harvesting; Urban Planning; Flood Mitigation; Sustainable Development; GIS Analysis; Green Infrastructure

ICSBE24_614

ECOLOGICAL SENSITIVITY OF ANCIENT AND MODERN BUILDINGS: CASE OF KANDY GRID CITY AREA

D.R.P. Godamunna[1*], H.M.S.M. Pitawala [2]
[1]University of Peradeniya, 20400, Sri Lanka
[2]CINEC Campus (Pvt) Ltd.Millennium Drive,IT Park,Malabe,Sri Lanka
**Correspondence E-mail: sunerapitawala@gmail.com, TP: +94 774381407*

Abstract: Ecological sensitivity in architecture refers to the integration of natural and sustainable elements into building design, construction, and operation. Modern architecture can learn from traditional building practices to achieve sustainability in the contemporary context. This study explores the ecological sensitivity of ancient and modern buildings within the Kandy Grid City area, a UNESCO World Heritage site in Sri Lanka, renowned for its historical and cultural significance. Data were collected through field surveys, stakeholder interviews, and observations, which were analysed using descriptive statistics and Microsoft Excel methods. The focus was on key structural components such as fences and materials used for roofs, walls, floors, doors, and windows. These data provided a detailed understanding of how traditional and modern buildings in Kandy utilize natural resources and respond to the environment. Kandy's architecture, particularly within its grid city layout, has historically demonstrated strong ecological sensitivity. Traditional buildings, such as temples, palaces, and colonial-era structures, were constructed using locally sourced materials like clay, timber, and stone. Passive cooling techniques were employed to regulate indoor temperatures, while architectural designs harmonized with the natural topography, minimizing environmental disruption. In contrast, modern buildings in Kandy often deviate from these practices, increasingly relying on materials like concrete, glass, and steel, which have higher embodied energy and environmental costs. This shift, driven by rapid urbanization and development pressures, has led to a decline in ecological sensitivity, as many modern structures lack consideration for the region's unique cultural and environmental context. The study evaluates the ecological sensitivity of both ancient and modern buildings in Kandy, assessing resource use, energy efficiency, and environmental integration. Findings indicate that a hybrid approach, combining traditional sustainable practices with modern technology, could guide Kandy's future development. This study advocates for green architecture principles, sustainable resource management, and climate-responsive designs to preserve Kandy's ecological and cultural heritage.

Keywords: Ecological Sensitivity; Sustainable Architecture; Kandy; Ancient and Modern Buildings

ICSBE24_615

FOREST AND URBAN INTERACTION: A CASE STUDY OF THE KANDYAN LANDSCAPE IN SRI LANKA

L. DISSANAYAKE[1]*, U. JINADASA[2], M. WJESURIYA[1], N. SENARATH[1]
D.R.P. GODAMUNNA[1*], H.M.S.M. PITAWALA [2]
[1]Department of Geography, University of Peradeniya
[2]Department of Archeology, University Peradeniya
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: Since the first urbanization in river valleys, cities have maintained close relationships with nearby forests, sustaining urban communities over millennia. The Kandyan landscape of Sri Lanka—a unique combination of urban environments and forest ecosystems is marked by complex socio-ecological processes, rich biodiversity, and cultural history. By examining the interaction of Kandy City—the capital of the last Kingdom of Sri Lanka—with surrounding forests and urban gardens, including Udawattakele, the Royal Forest of the kingdom, the Royal Botanical Gardens of Peradeniya and Kandyan home gardens, this study investigates the relationship between forests and urban environments through ecosystem services. Using literature, historical sources, geographical data, and satellite images, the study identifies the dynamic relationship between cities and forests and their mutual benefits to ecosystems and urban communities. This study offers insights into the opportunities, challenges, problems, and lessons related to urban-forest interactions in the Historic Urban Landscape of Kandy. The results show that urban forests and gardens have contributed to the sustainability of the city over centuries, playing a vital role in Kandy's historic cultural landscape—the cultural center of the country—which was designated a World Heritage City in 1988. Over the centuries, Kandy's landscape has changed significantly, moving from untouched natural areas to regions heavily affected by human activity. This transformation, especially over the last six hundred years, has significantly reduced urban forest cover and weakened important ecosystem services. This study highlights the urgent need for community involvement to protect Kandy's urban landscape by clearly marking forest reserve boundaries, enforcing existing regulations, and raising awareness among residents and visitors about the ecological value of these areas. The findings also emphasize the importance of policies that balance urban growth with environmental protection. Tools like remote sensing offer promising ways to monitor and manage the interactions between urban areas and forests to support sustainable development.

Keywords: Urban Forest; Ecosystem Services; Kandyan Landscape; Sustainability

ICSBE24_616

STREAM MODIFICATION AND FLOOD IMPACTS IN URBAN TOWNS: A CASE STUDY OF AKURANA IN SRI LANKA

R.M.C.D. Jayaweera[2], A.A. Pandigama[2], M.K. Madushani[2], D.D.P. Kumari[2], H.B.S. Kavindi[2], L. Dissanayake[1*]

[1]Department of Geography, University of Peradeniya, Sri Lanka
[2]Department of Environmental and Industrial Sciences, University Peradeniya
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: The land use changes and several modifications to the Pinga Oya, Akurana in Sri Lanka have significantly contributed to the increasing the risk of flooding in that area. This study identified a high number of illegally constructed bridges over Pinga Oya, which are narrowing the width of the stream at its base and thereby reducing its carrying capacity. Flash floods have been common in the area enhanced by heavy monsoonal rains, underlining the combined effect of stream modifications and unsustainable urbanization. The increasing flood impact in Akurana signifies the need for integrated urban flood management because of the loss of permeable surfaces affecting the local communities and economies. This study records 52 bridges with retention walls at their base that alter the nature of the stream banks within the subjected 2 km along Pinga Oya. Methods used included field surveys and mapping to determine the extent of stream modifications and their effects on natural flow regimes and flood risk. Even with connectivity and ease of access, urban modifications show that natural stormwater flow disruption results in a decrease in the carrying capacity of Pinga Oya with heavy rains. The linkage between alteration to an urban stream and flash flooding illustrates the need for planning infrastructure capable of withstanding flood events. The findings of the study suggest a well-planned network of roads and bridges for public transportation over Pinga Oya, increased vegetation plots, and engineered permeable surfaces for the catchment area to assist in the infiltration of rainwater for less runoff. Moreover, it may also suggest better stream management practices and rigid policies that can permit urban development to coexist with ecological resilience. These findings provide valuable insight into flood risk reduction and prove useful to citizens affected by floods in Akurana, policymakers, urban planners, and other environmental managers in Akurana and other areas undergoing rapid urbanization. This work underlines the urgent need for sustainable town planning at areas of flood risk to enable an infrastructure that provides services not only for the needs of an urban settlement but also enhances natural flood mitigation.

Keywords: Urbanization; Stream Modification; Flooding; Pinga Oya; Sustainable Urban Planning

ICSBE24_617

THE ROLE OF URBAN CEMETERIES IN ECOSYSTEM SERVICES: THE CASE OF KANDY, SRI LANKA

D.M.L. Dissanayake[1*], P.G.R.A. Nayanthima[1], D.R.P. Godamunna[2]
[1]Department of Geography, University of Peradeniya
[2]Department of English Language Teaching, University of Peradeniya
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: This paper explores the role of urban cemeteries as green spaces contributing to ecosystem services, specifically focusing on the city of Kandy in Sri Lanka. The urban environment faces several issues as a result of city growth and densification, including the loss of green space quantity and quality, biodiversity decline, ecosystem degradation, and human-environment alienation. humans from nature, which has an impact on their well-being, both physically and mentally. Urban forests and trees are typically the first things that come to mind when discussing urban green spaces. Urban parks, gardens, and lanes, but graves are usually disregarded. Mahayiyawa, Garrison, and War are active and preserve cemeteries in Kandy municipal council area with less attention for ecologically valued green patches in urban environments, and the study aims to analyze the role of urban cemeteries in biodiversity conservation and nature protection and the ecosystem services and habitat potentials they provide and also identify the challenges facing these cemeteries. This study combines field observations, ecological surveys, and interviews with residents and cemetery managers to evaluate the environmental, cultural, and social contributions of cemeteries in Kandy. The findings demonstrate that the old, active, and preserved cemeteries can provide "spot habitat" for native species gradually squeezed out of intensively used rural landscapes, such as special endemic species. Kandy's cemeteries significantly contribute to ecosystem services such as carbon sequestration, biodiversity support, and mental well-being not only for urban dwellers but also for nature lovers and connection with the all local and foreign connection of the burial monument. Kandy cemeteries provide ecosystem services in the same way as traditional urban green spaces, and their ecosystem services are similar: air quality, regulation of local climate and water balance, reduction of urban heat island effects, wood fuel from tree care, habitat for pollinators, and aesthetic and recreational values offering insights into sustainable urban planning. The study suggests the following factors should be implemented: Such as raising public awareness about the values of the site, diversification of burial customs and maintenance technologies, avoiding chemical weed control, reduction of invasive plants, preference for native plants, community involvement in planning and in maintenance, and enhancing cemetery managers.

Keywords: Urban Cemeteries; Ecosystem Services; Biodiversity Conservation; Urban Green Spaces; Sustainable Urban Planning

ICSBE24_618

VEGETATION CHANGES IN URBAN STREAM CORRIDORS: A CASE STUDY OF THE PINGA OYA URBAN-RURAL GRADIENT

N.M.G.I. Udari[1], B.G.W.M. Sriyananda[1], K.N.K. Kankanamge[1], J.M.S.G.B Navarathne[1], L. Dissanayake[2*]

[1]Faculty of Science, University of Peradeniya
[2]Faculty of Arts, University of Peradeniya
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: Stream corridors are ecosystems, and they have valuable ecological functions, including providing habitat, regulating water quality, and supporting biodiversity. Urbanization has led to observable changes in the vegetation composition and structure along the River Mahaweli tributary in the Pinga Oya corridor. Increased human activities in urban zones, including construction, pollution, and modified hydrology, disrupt natural vegetation patterns, leading to invasive species, reduced biodiversity, and altered ecosystem functions. The objective of this research is to document vegetation types and composition along the Pinga Oya urban-rural gradient, distinguishing between urban, suburban, and rural sections. Also, to analyzes vegetation changes and patterns in response to varying levels of urbanization, including species diversity, density, and occurrence of invasive species. Sample locations were selected along the stream corridor covering the urban, suburban, and rural segments. The line-transect method followed for the vegetation survey. Transect lengths varied based on flow area dimensions (40 m length if flow-length > 4.6 m, 20 m length if flow-length < 4.6 m at both sides of the stream). The data was analyzed using the Shannon-Weiner index and visual data interpretation method. The study revealed a clear decline in biodiversity with increasing urbanization. Plant species counts in rural, suburban, and urban areas were 44, 31, and 8, respectively, with corresponding Shannon-Wiener Index values of 2.44, 1.76, and 0.37. In every area, invasive species such as *Panicum maximum, Miconia crenata, and Eleusine indica* were observed, and the percentage of distance these species covered in each area was calculated. Invasive species covered, in urban areas, 63.55%, in suburban areas 56.37 %, and in rural areas 50.99 % of the distance measured. The findings underscore the need for conservation and restoration strategies to mitigate biodiversity loss and invasive species proliferation in urban stream corridors, thereby maintaining their ecological integrity and ecosystem services.

Keywords: Pinga Oya; Urban-rural Gradient; Line-transect; Vegetation Survey; Shannon-weiner Index

ICSBE24_619

WATER POLLUTION IN THE URBAN SEGMENT OF PINGA OYA DURING FLOOD SITUATIONS

W.R.M.N.R. Wickramasinghe[1], R.T. Jayasinghe[1], P.C.L. Kapugama[1], J.G. Ilakshika[1], A.R. Ushani[1], L. Dissanayake[2*]

[1]Department of Environmental and Industrial Sciences, University Peradeniya, Sri Lanka
[2]Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: River water pollution is a rising concern that poses significant risks to human health and river-sustained ecosystems. Unregulated urban expansion and improper waste disposal lead to the encroachment of rivers significantly impacting the hydrological regime, making the adjacent area susceptible to flash floods posing numerous adverse consequences in addition to water pollution. Akurana area with a high population density in the Kandy district associated with the Pinga oya catchment area has experienced frequent flash floods recently, disturbing the daily lifestyle of the residents due to water pollution among many other consequences. The objective of this study was to investigate the water quality of Pinga Oya during flood situations to assess the potential pollution levels. Water samples were collected from different places of Pinga oya encompassing urban, semi-urban and rural regions two days following the inundation of the area, and comprehensive water quality analyses were carried out through field and laboratory testing. Potential point sources of water pollution were explored at the sample collection points. In this context, point sources comprising the direct release of wastewater from residential taps along with commercial effluent and hotel wastewater, flowing directly into the river were identified. It is suspected that latrine sewage systems and other wastewater outlets being directly connected to the river contribute to severe pollution levels in addition to pollution by runoff which is a main non-point source. The results revealed that samples from the urbanized area of Akurana had a turbidity of 27.3 NTU, pH of 7.54, Total Dissolved Solids (TDS) level of 123 ppm and conductivity of 232 µS/cm. Compared to rural water samples, urban samples depicted very low Dissolved Oxygen (DO) levels pointing out severe oxygen depletion implying excessive pollution levels in the urban area drawing immediate attention to implement effective pollution mitigation strategies in sustainable urban planning.

Keywords: Flash Floods; Point Sources; Sustainable; Urban Planning; Water Pollution

ICSBE24_620

SOLID WASTE MANAGEMENT ISSUES DURING FLOOD HAZARDS IN URBAN ENVIRONMENTS – CASE STUDY OF AKURANA, SRI LANKA

L. Dissanayake[2], H. Ayesha[1], D. Deepthika[1], I. Hemachandra[1], M. Hapugoda[1], S. Hettiarachchi[1]

[1]Department of Environmental & Industrial Sciences, University of Peradeniya, Sri Lanka
[2]Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: Akurana is a densely populated town in the Central Province of Sri Lanka, that faces many problems related to Solid Waste Management (SWM), especially during heavy rainfall that brings about flood conditions. This study aims to assess the current SWM, its relationship with seasonal floods, and the impacts of their combined effect on the community while gauging possible solutions. The study area included Kudugala town and extended 2 kilometres North along the Pinga Oya stream, particularly the A9 highway along the town centre. Direct observational evaluations along with testimonies from local authorities and residents were used to identify the major amounts, categories and sources of solid waste, as well as the major issues associated with their collection, transport and ultimate disposal. The study was able to recognize that the current SWM is mainly mediated by the Akurana Pradeshiya Sabha which dispatches waste collection trucks designated for each Solid Waste (SW) type, for waste collection, followed by final dumping. SW heaps along street sides were a common occurrence, despite daily collection. The major bulk of SWM consisted of biodegradable domestic waste, followed closely by non-degradable plastic and polythene waste. Most waste originates from non-point sources, namely households with some commercial enterprises making larger contributions. SW types within the Pinga Oya stream were mainly demolition waste and damaged banking material (rubber tires, sandbags, fabrics etc.) Unplanned constructions along the stream bank, septic clearance into the stream, and supporting columns built atop the riverbed were observed to disturb stream flow while contributing to the solid waste added to the stream. Community testimonials revealed several issues in SWM including waste dumping by non-locals via vehicles, low frequency of collection trucks in residential lanes, and unwillingness to make payments for collection. The study also identified that flood risk is imminent even when uphill areas alone receive heavy rainfall as the sediment carried often hinders urban drainage and water flow in the Pinga Oya stream. Elevated water levels reach the road and disturb the scattered SW collection points. Means of transport are stalled until flood draining which often delays waste collection by trucks. In summation, the study identified the pressing need for a more resilient SWM mechanism, better infrastructure and community engagement in implementing sustainable SWM during floods.

Keywords: Solid Waste Management; Akurana; Floods

ICSBE24_888

ANALYSIS OF TRAFFIC PATTERNS IN AKURANA TOWN DURING FLOOD SITUATIONS AND NORMAL CONDITIONS

K.S. Rathnayaka[1], B.E. Wickramasinghe[1], J.V.S. Samanmali[1], K.M.C. Wijerathna[1], S.B. Prasangika[1], L. Dissanayake[2*]

[1]Department of Environmental and Industrial Sciences, University of Peradeniya, Sri Lanka
[2]Department of Geography, University of Peradeniya, Sri Lanka
**Correspondence E-mail: dissanayakela@arts.pdn.ac.lk, TP: +94718075726*

Abstract: Akurana, a growing urban centre in Sri Lanka's Kandy District, and tributary of River Mahaweli Pinga Oya is passing through this town centre and experiences frequent traffic disruptions, especially during flood events. Due to the town's location and inadequate infrastructure, flooding leads to road congestion, prolonged travel times, and road safety issues, affecting residents and businesses alike. Understanding the traffic patterns during flood conditions compared to regular days is crucial for improving traffic management and emergency response. This study aims to analyze traffic flow in Akurana under flood conditions versus regular conditions to develop strategic solutions for effective traffic management and to mitigate the negative impact of flooding on mobility. Primary and secondary data sources were utilized, with calculated traffic volumes analyzed at critical points across the town. Surveys and field observations revealed several underlying factors contributing to congestion, such as buildings and shops constructed too close to the Pinga Oya and A9 main road, limiting road width. A significant reliance on private vehicles among residents further strains traffic flow, while the town's multiple access points, lack of traffic signals, and on-street parking amplify congestion issues. Additionally, large vehicles often obstruct road signage, and irregular pedestrian behaviour contributes to traffic delays, particularly during peak hours. The study recorded typical traffic volumes of 950, 827, and 1307 vehicles per hour at the entry to Akurana, core town area, and exit of Akurana town towards Kandy to Jaffna, respectively. During flood events, road closures force traffic onto bypass routes, resulting in congestion on these alternative roads. This analysis provides a comprehensive understanding of the traffic impacts associated with both normal and flood conditions in Akurana, with recommendations aimed at improving infrastructure and implementing strategic traffic management practices to alleviate congestion in this flood-prone urban area.

Keywords: Akurana Town; Flash Flood; Traffic Congestion; Traffic Flow Volume

ICSBE24_889

A SPATIAL STUDY ON THE ECOLOGICAL SIGNATURES OF LANDSCAPES IN COLOMBO

J.C. Subasinghe[1*], T.M.C.I. Madhushani[2], P.I.A. Gomes[2]
[1]Water corporation, Western Australia
[2]Sri Lanka Institute of Information Technology, New Kandy Road, Malabe
**Correspondence E-mail: ayantha.g@sliit.lk, TP: +94712972018*

Abstract: Urbanization is a governing demographic feature and a significant part of global land transformation. According to the United Nations, more than half of the world's population lives in urban areas. If not studied and managed properly, urbanization can affect negatively its residents, and in Sri Lanka, this is about 20 % - 30 % in commercial areas and residential areas. Yet, studies related to exploring the functions and status quo of different land uses are rare and rather unfound in Sri Lanka. In this study the variations of temperature, humidity, soil moisture, infiltration rate, shrub cover and tree richness with different land uses namely, cemeteries, parks, residential areas and institutes have been investigated to see whether the land uses actually are the landscapes people perceive. It was found that the humidity of land plots with Institutes is significantly higher than all the other landscape types. Interestingly, it was observed that parks and cemeteries possessed high humidity levels while Institutes and Residential areas possessed a comparatively lower humidity level. The soil moisture content and infiltration rates of institutional landscapes significantly differed from those of other landscape types. Shrub cover variation between Residential areas and Institutes was insignificant, while shrub cover of all the other landscape types resulted in substantial differences with a significance level of 0.00. The analysis of variation of multiple ecological factors under landscape types depicted that for all the temperatures, the shrubs cover percentage of cemeteries lies higher than the rest of the landscapes. In cemeteries, initially, the shrub cover increased with the humidity and with increments of humidity level, the shrub cover decreased. Overall sense, the Institutional areas depicted relatively adverse livable conditions, and the Cemeteries depicted the most favorable conditions, interestingly it was better than the Parks. This study gave insights into how these landscapes are best managed and engineering interventions needed in that regard.

Keywords: Colombo; Ecology; Landscapes; Urban Planning; Vegetation

ICSBE24_776

ENHANCING THERMAL COMFORT IN THE CONSTRUCTION INDUSTRY USING DIGITAL TWIN TECHNOLOGY: A SYSTEMATIC REVIEW

K. Keerthana[1*], W.A.D.C.S. Perera[1], T.A.N.T. Perera[2], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka
[2]Department of Export Agriculture, Uva Wellassa University, Sri Lanka
[*]Correspondence E-mail: keerthanakanapathipillai4@gmail.com, TP: +94771178780

Abstract: Digital Twin (DT) technology is a novel approach to the design and operation of the built environment that creates virtual replicas of buildings. Thermal discomfort caused by inefficient energy use in buildings affects occupant well-being, productivity and overall experience - a discomfort which would not be endured if prevented from being in the building. Thermal comfort is a state in which occupants experience a level of heat energy that is comfortable for them. The investigation included systematically reviewing the literature on DT applications for optimizing thermal comfort within the construction industry as well as its interconnection with real time environmental monitoring technologies. A review of 28 peer reviewed articles that have been publish since 2015 until 2024, sourced from Scopus using the search terms; “Digital Twin”, “Thermal Comfort” and “Buildings”, was conducted. Full-text access, English language, and scope to research was the criterion by which articles were considered for analysis at the exclusion of duplicates and papers with insufficient content. It is found that the use of DT technology with the functionality of IoT and BIM to enable real time monitoring of environmental parameters (temperature, humidity, air velocity, Mean Radiant Temperature (MRT)). Predictive modeling is improved using advanced machine learning algorithms such as Artificial Neural Networks (ANN), Graph Neural Networks (GNNs), and Bayesian Networks, improving accuracy for thermal comfort optimization by 14-28%. Centralized visualization of occupant and environmental data, platforms such as Neo4J and Unity, and emerging tools such as Build2Vec, integrate occupant data to enhance comfort predictions. The results of the study indicate the transformative ability of DT technology in bringing change to thermal comfort management by optimizing AI driven HVAC and utilizing real-time integrations. Finally, future research should consider modeling these technologies in adaptive, occupant specific fashion and their scalability across building type and climate.

Keywords: BIM; Building; Digital Twin; IoT; Predictive Modelling; Thermal Comfort

ICSBE24_775

INTEGRATED GEOTECHNICAL AND GEOPHYSICAL APPROACHES FOR LANDSLIDE RISK ASSESSMENT IN TROPICAL REGIONS

V. Nirthani[1*], A.H Weerakoon[1], T.A.N.T. Perera[2], C.S. Bandara[3], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka
[2]Department of Export Agriculture, Uva Wellassa University, Sri Lanka
[3]Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka
[*]Correspondence E-mail: nirthu18@gmail.com, TP: +94769637879

Abstract: Natural hazards such as Landslides (LSs) are important in tropical areas bearing steep slopes, high rainfall, and can also lead to a significant loss in human life, infrastructure, and property. Understanding the intimately linked relationship between geological, geotechnical, hydrological, and climatic factors that act to produce LS enables us to accurately define the hazard potential and effectively assess and mitigate risks. This work examines the linking of geotechnical and geophysical methods in order to improve the evaluation of LS risk. A series of 25 peer – reviewed articles in the period between 2013 to 2023 were reviewed combining ScienceDirect and Google Scholar. In the search strategy were used terms of "landslide," "geotechnical approaches," and "geophysical approaches" in English publications offering detailed information on the LS risk assessment. Open-access and full-text availability of articles, as well as robust citations, were considered criteria for selection, while duplicates were excluded. Geotechnical methods including borehole data analysis, Cone Penetration Testing (CPT), soil sampling, and stratigraphic studies are critical for determining the physical and mechanical properties of subsurface materials, and LS occurrence. Sliding surfaces, subsurface structures, and potential instability predictions are effective in mapping by using complementary geophysical methods including Electrical Resistivity Tomography (ERT), Ground-Penetrating Radar (GPR), and Time-Domain Reflectometry (TDR). Standalone approaches are limited in capturing the nature of LS that is multifaceted, and as such, integrated methodologies have been necessary to achieve this. This paper outlines that a geotechnical and geophysical approach can provide a greater insight to LS risk assessment. Here we demonstrate how the dual approach of detailed subsurface data and advanced imaging can be used to produce accurate risk prediction and development of targeted LS mitigation strategies. In landslide prone regions, these findings give critical insights to policymakers, engineers and researchers aiming to enhance resilience against this pervasive hazard.

Keywords: Cone Penetration Testing (CPT); Electrical Resistivity Tomography (ERT); Geophysical Approaches; Geotechnical Approaches; Integrated Approaches; Landslide Risk Assessment

ICSBE24_772

SMART PARTNERSHIPS: INNOVATING INDUSTRIAL TRAINING THROUGH ENHANCED UNIVERSITY-INDUSTRY COLLABORATION IN SRI LANKA

M.M.S.T. Jayamali[1*], W.G.M. Randika[1], K.M.C. Tharupath[1], G.Y. Jayasinghe[1]
[1]Department of Agricultural engineering and environmental technology, faculty of agriculture,University of ruhuna
[*]Correspondence E-mail: sachinithisara100@gmail.com , TP: +94714197224

Abstract: Boosting collaboration between industry and the university is an important social factor that forms the national innovation system. Despite the efforts of many developed economies to foster such linkages, the majority of the developing nations are still working towards achieving this important connection. The objectives of the present study were as follows: (a) To find out the present status of university-industry collaborations in the Sri Lankan universities, and (b) To understand the perception of the undergraduates towards industrial training, the reasons for the lack of development of this area and the gap between the industry requirement and the graduates produced. A systematic literature review and survey with pretested questionnaire were conducted. Data were collected from the new entrants, consisting of 225 students from state Universities of Sri Lanka and major trends were analyzed. The trends that emerged included Industrial Training participation, the Academic year in which industrial Training is done at the University, the duration of the Industrial Training, etc. A large number (85 %) have never undergone industrial training as one of the requirements towards the completion of their degrees. From the survey results concerning the year in which industrial training is done, it was evidenced that the majority of students (50 %) undergo industrial training in their last year of study. Only 13 % of the students undergo industrial training in the third year while a very small proportion of the students (3 %) has industrial training in the second year and (34 %) of the students are not sure of when they undertake industrial training. This implies a gap in the early practical experience in real-world industry that may affect the readiness of students for entrepreneurship. Only 2 % of the respondents are not aware of the duration of the industrial training. There is clear evidence that there is a gap in Industrial Training and thus a need for improvement in the linkage between the university and industry. The students had little knowledge of industrial training related activities. Therefore, these findings provide new and important understandings of relevance to future research. These gaps in early exposure to industrial training may be filled in order to prepare undergraduate students in Sri Lankan universities with the necessary skills and attitudes for entrepreneurship, ultimately contributing positively to the development of regional economies and innovations.

Keywords: Academia-industry Synergy; Industrial Training; Smart Partnerships; University-industry Collaboration; University-industry Dynamics; Workforce Development

ICSBE24_778

SUSTAINABLE TRANSFORMATIONS IN SRI LANKA'S TEA INDUSTRY: CIRCULAR ECONOMY PRACTICES IN VALUE ADDITION, POST-HARVEST PROCESSING, AND WASTE MANAGEMENT

I.A.T.D.S. Karunasinghe[1*], S.M.S.N. Senanayake[2], P.R.T. Ariyarathna[1], G.R.P. Hettiarachchi[3], P.R.B.W. Dhananjaya[4], J.M.H.M. Upulwehera[5], W.G.M. Randika[6], M.M.S.T. Jayamali[6], Pradeep Gajanayake[7]

[1]Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka
[2]Faculty of Graduate Studies - University of Ruhuna
[3]Hector Kobbekaduwa Agrarian Research and Training Institute
[4]Faculty of Applied Sciences, Rajarata University of Sri Lanka
[5]Faculty of Social Sciences and Humanities, Rajarata University of Sri Lanka
[6]Faculty of Agriculture, University of Ruhuna
[7]Faculty of Technology, University of Sri Jayewardenepura
**Correspondence E-mail: thenayanidsk@gmail.com, TP: +94766205276*

Abstract: This review explores recent circular economic trends and sustainable development impacts within Sri Lanka's tea industry, particularly in post-harvest processing, value-added product development, and waste management. The Sri Lankan tea industry has emphasized high-quality, certified products for international markets, combined with innovative waste management practices, highlighting its potential for economic resilience and environmental sustainability. The methodology involved a systematic review process from a total of 16 peer-reviewed journals published during 2020-2023 on Web of Science and Google Scholar databases, with predefined inclusion criteria guiding the screening and selection process. A detailed literature search was carried out by selecting several keywords "Circular Economy", "Post-Harvest Processing", "Sustainable Tea Industry", "Value Addition", and "Waste Management". From an economic perspective, the Central Bank reports in 2023 elaborate that Sri Lanka's tea industry contributed $1,309.9 million to the composition of export value, accounting for 11 % of all agricultural exports. The Ceylon Tea captured a 10 % share of the international market in 2022. The study's literature elaborates that post-harvest innovations including renewable energy, such as solar power, and energy-efficient machinery significantly reduce the industry's carbon footprint and conserve resources. Value-added product development introduces diversified offerings like ready-to-drink tea and herbal blends. Organic certifications and the adoption of biodegradable packaging further strengthen global reputation. In waste management, sustainable practices include the conversion of tea by-products into compost and bioenergy. The reuse of tea leaves for wastewater treatment and bio-based materials represents circular economy principles, while smallholder development societies provide vital support to improve sustainability at the grassroots level. The study suggests as a value-added product development, tea-based cosmetics to be introduced. As post-harvest innovations water recycling systems, and introducing drone technology to observation might bring diversified offerings to the plantation area. In waste management, the industry is suggested to utilize 'tea by-products' converting them into 'biochar' while enhancing environmental sustainability in Sri Lanka's tea industry.

Keywords: Circular Economy; Post-harvest Processing; Sustainable Tea Industry; Value Addition; Waste Management

ICSBE24_781

FOSTERING ENTREPRENEURIAL INTENTIONS AND OVERCOMING CHALLENGES IN STUDENT ENTREPRENEURSHIP THROUGH UNIVERSITY-INDUSTRY COLLABORATION IN SRI LANKA

W.G.M. Randika*, M.C. Karunadasa, M.M.S.T. Jayamali, K.M.C. Tharupath, G.Y. Jayasinghe

. [1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna

**Correspondence E-mail: randi960618@gmail.com, TP: +94712059597*

Abstract: One of the major factors that affect inflation in Sri Lanka is high unemployment rate particularly among women. Solving this problem through entrepreneurship is deemed as one of the most effective approaches. Promoting new business ventures, especially among the undergraduate students, is vital in the fight against unemployment and economic recession in developing countries. This work aims to explore the determinants and barriers of student entrepreneurship in Sri Lankan higher education institutions. A cross-sectional study was conducted during September to December 2023 with 225 respondents from the University of Ruhuna's Faculty of Agriculture including 123 final year students, 53 academic and 38 industrial personnel. The study concludes that University-Industry Collaboration (UIC) is crucial in the development of the agro-industry through research and innovation. However, funding constraints can be managed and have a positive impact on technology transfer and growth through proper communication. The survey shows that industrial training should begin in the early stages of a student's learning and should include both theoretical and practical aspects. It focuses on the importance of addressing the industrial sponsorship problems in order for the students to develop entrepreneurial attitudes. This shows the students' business interests in continuing their further education in UIC. However, there has been a general recommendation for university departments to embrace business development and industrial training more than they currently do. The participants stated that they wanted more enhanced versions of UICs as well as online courses in entrepreneurship. The prospects for UIC projects are encouraging and can be enhanced with the addition of business units and extracurricular activities. The purpose of this study is to improve the level of entrepreneurial literacy among university students in order to reduce the unemployment rate and enhance sustainable development in Sri Lanka, which will be helpful for students, educators, and policy makers.

Keywords: Challenges in Student Entrepreneurship; Entrepreneurial Intentions; Student Entrepreneurship; University-industry Collaboration; Unemployment

ICSBE24_782

ASSESSING VERTICAL GREENING SYSTEMS FOR INDOOR AIR QUALITY ENHANCEMENT IN URBAN ENVIRONMENTS: A SUSTAINABLE APPROACH TO BUILT ENVIRONMENT HEALTH

M.C. Karunadasa[1], K.G.N.H. Weerasinghe[2], R.U. Halwatura[2], G.Y. Jayasinghe[1]
[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Kamburupitiya 81000, Sri Lanka
[2]Department of Civil Engineering, University of Moratuwa, Bandaranayake Mawatha, Katubedda 10400, Sri Lanka
Correspondence E-mail: monashakarunadasa@gmail.com, TP: +94716543340

Abstract: Vertical greening systems (VGS) are sustainable architectural practices that allow vegetation to be accessed across a building's exterior or interior walls. VGS are becoming popular as a sustainable solution to minimize the heat island effect. This research aimed to compare the performance of air conditioning rooms with and without VGS to improve indoor air quality, evaluate the perceived comfort and well-being of occupants in buildings with VGS and air-conditioning, and analyze the environment impact of with and without VGS comparing to CO_2 absorption levels. The study used *Spathiphyllum blandum* (Peace lily) and *Piper Longum* (Thippili) as planting species in an experiment. The study found that in a single-person bedroom, the peace lily based VGS achieved a 10.3 % reduction in CO_2 generation, while the Thippili based VGS achieved an 11.82 % reduction. In a double-person bedroom, the Peace Lily-based VGS resulted in a 13.46 % reduction, and the Thippili-based VGS resulted in a 17.72 % reduction. Thippili plant setup reduce CO_2 at a higher rate per hour (0.00146 kg/hr) and per year (12.79 kg/year) compared to Peace Lily plant setup , which reduces 0.00123 kg/hr and 10.81 kg/year. Overall, while both plants contribute significantly to lowering CO_2 levels. The findings suggest that *Piper longum* may serve as an effective indoor plant for CO_2 reduction within enclosed space. The observed reduction in CO_2 levels achieved by Peace Lily and Thippili in vertical green systems (VGS) highlights a promising approach to enhancing indoor air quality in urban offices and residential apartments.

Keywords: Indoor Air Quality; Indoor Plant; Sustainable Architecture; Sustainable City Planning; Vertical Greening Systems (VGS)

ICSBE24_552

A SYSTEMATIC REVIEW OF UNIVERSITY-INDUSTRY COLLABORATION: ENHANCING THE TRIPLE BOTTOM LINE FOR SUSTAINABILITY

D.P.T.T. Silva[1,2*], G.Y. Jayasinghe[3]

[1]*College of Ocean and Meteorology, Major of Marine Science, Guangdong Ocean University, Zhanjiang 524088, Guangdong, China*

[2]*School of Chemistry and Environment, Guangdong Ocean University, Zhanjiang 524088, Guangdong, China*

[3]*Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Mapalana,81100, Kamburupitiya, Sri Lanka*

**Correspondence E-mail: silvathusharikatharangani@gmail.com, TP: +94778831723*

Abstract: University education represents the peak of academic achievement and personal growth. The industries functioning for their final goals, and it is typically focus on the profit enhancement while they failure to address the other sustainable aspects. It causes to enhance the environmental pollution, improving the number of unsatisfied or less satisfied employees in the industries and long-term profit reduction. The university industry collaboration plays a vital role in advancing sustainable development, addressing complex environmental challenges and societal issues, and development of economic growth. This paper delves into the multifaceted domain of university-industry partnership for sustainable development. It explores the intricate dynamics of these partnerships, their potential to drive sustainable progress, and the challenges that underpin this collaboration. This review provides a comprehensive overview of how these partnerships fit with the United Nations Sustainable Development Goals, showing their ability to make positive global changes, the advantages that can be capture for the both parties by collaborative work, the challenges and the solution to overcome from those and the different kinds of models and industries that achieved sustainability with the aid of the strong bond between academia and industries. Moreover, this study identified the successful methods and creative ideas that can make sustainability and stresses the importance of a developing a standard way to move students from academia to the relevant industries to address for the bottom triple aspects of sustainability. Finally, it provides an inspiration for the further research studies and development of the path to transfer the innovations, and the knowledge collected from the research, directly into industries to enhance the production quality, efficiency and reduction of the cost per product by reducing the resource requirements.

Keywords: Industry-Academia Collaboration; Sustainable Development Goals; University Education

ICSBE24_850

ANTIBIOTIC RESISTANCE SPECTRA OF *E. coli* ALONG THE UPPER MAHAWELI RIVER SEGMENT OF SRI LANKA

F. Fareed[1,2,3], P.T.A. Thilakarathna[1,2], R. Jinadasa[1], F. Noordeen[1], S.K. Weragoda[3], Yawei Wang[4], Yuansong Wei[4], Zhang Yu[4], Min Yang[4], S.H.P.P. Karunaratne[1*]

[1]University of Peradeniya, Peradeniya, Sri Lanka
[2]Postgraduate Institute of Science, Peradeniya, Sri Lanka
[3]China-Sri Lanka Joint Research and Demonstration Centre (JRDC) for Water Technology, E O E Pereira Mawatha, Meewathura, Peradeniya, Sri Lanka
[4]Research Centre for Eco-Environment Sciences, Chinese Academy of Sciences, Beijing, China
**Correspondence E-mail: shppk@sci.pdn.ac.lk, TP: +94775810261*

Abstract: Water quality is vital for public health and environmental sustainability. Contamination of water with antibiotic-resistant bacteria, resulting from excessive use of antibiotics, causes a significant global health challenge. Present study aimed to evaluate antimicrobial resistance of *E. coli* bacteria isolated from the intakes of 15 water treatment plants (WTPs) located along the Mahaweli River segment between Kotmale and Victoria reservoirs. Isolation of *E. coli* was done using the membrane filtration technique as per the guidelines of the American Public Health Association (2022), followed by a series of biochemical tests for confirmation. Antibiotic resistance bioassays were conducted by Kirby-Bauer disc diffusion method using ten antibiotics i.e., amoxicillin (AMX-30), cefuroxime (CXM-30), cefoxitin (CX-30), ceftazidime (CAZ-30), augmentin (AUG-30), tetracycline (TE-30), co-trimoxazole (COT-25), streptomycin (S-25), ciprofloxacin (CIP-5) and chloramphenicol (C-30), according to Clinical and Laboratory Standards Institute (CLSI) guidelines (2021). Antibiotic Resistance Indices (ARI) and Multiple Antibiotic Resistance Indices (MARI) were calculated to quantify the resistance burden within bacterial populations. The study revealed significant antibiotic resistance patterns, with 60.5% (n=101) colonies resistant to at least one antibiotic, 44.3% (n=74) to more than two and 27.5% (n=46) to more than three antibiotics. Notably, 10.8% (n=18) displayed multidrug resistance against more than five antibiotics tested. AMX-30 showed the highest resistance of 47.3% (n=79), followed by TE-30 26.9% (n=45) and COT-25 24.0% (n=40), while CIP-5 and C-30 exhibited the lowest resistance 4.8% (n=8). The findings highlight significant resistance to widely used antibiotics such as AMX-30 and TE-30, raising public health concerns. The MARI values for *E. coli* ranged from 0.00 to 0.80, with 17.4% (n=29), exceeding the acceptable threshold by over twofold. The ARI values ranged from a minimum 0.00 in Thalawakelle-Galkanda intake, which is located in a forested area, to the highest 0.32 in Paradeka intake, situated in an urbanized zone. Although the ARI values exceeded the threshold at eight of the 15 tested locations, the overall ARI for the Mahaweli River segment was 0.17. Results indicate the developing trend of antibiotic resistance in river bacteria affecting the river ecosystem and public health. Our study highlights the need for continued monitoring and active mitigation efforts preserving the environment.

Keywords: Antibiotic Resistance; *E. coli*; Mahaweli River; Antibiotic Resistance Index; Multiple Antibiotic Resistance Index

ICSBE24_851

ENHANCED CONFIRMATION OF ENVIRONMENTAL CONTAMINANTS: SUGGESTED A NOVEL METHOD TO DETECT MCPA IN WATER BY UV/ FLUORESCENCE HPLC WITH SPE EXTRACTION

K.T. Nawarathne*, P.M.C.J. Bandara, M.S.P.P.R. Priyadarshana, Y. Jayawardhana, D.R. Samarajeewa

China-Sri Lanka Joint Research and Demonstration Centre (JRDC) for Water Technology, E O E Pereira Mawatha, Meewathura, Peradeniya, Sri Lanka

**Correspondence Email: nawarathnekasuni@gmail.lk, TP: +94755328906*

Abstract: The proper identification and quantification of organic contaminants in environmental samples are critical for assessing health risks. For analyzing environmental contaminants, High-Performance Liquid Chromatography (HPLC) coupled with Ultraviolet (UV) and Fluorescence (FLD) detectors is a robust analytical technique. This study evaluates the potential of UV/FLD response ratios as a confirmatory tool for identifying organic contaminants, with MCPA (2-methyl-4-chlorophenoxyacetic acid), one of the most commonly used herbicides in agricultural and horticultural applications, serving as a model compound. MCPA was extracted from surface water samples using Hypersep C18 cartridges and eluted with a 50% acetonitrile-methanol mixture. The pH was adjusted to 2.24–2.26 for both samples and standards to enhance peak intensity. The calibration of the UV and FLD detectors for MCPA has shown excellent linearity with regression coefficients (R^2) higher than 0.995. The recoveries exceeded 70% for pre-spiked and post-spiked samples, demonstrating the method's reliability. A characteristic UV/FLD response ratio between 1.5 and 1.9 was established for MCPA, providing an additional dimension of selectivity and confirmation of its identity in environmental matrices. This ratio remained stable across the extracted samples and standard solutions demonstrating its resilience as a confirmatory measure. Integrating UV/FLD response ratios with HPLC offers a valuable approach for enhancing the identification and quantification of organic contaminants in complex environmental matrices. The success of this approach with MCPA suggests its potential for broader environmental monitoring applications, particularly for fluorescent contaminants and this approach combines the strengths of UV and FLD detectors to meet critical demands in environmental health risk assessment and resource management.

Keywords: High-Performance Liquid Chromatography;
2-methyl-4-chlorophenoxyacetic Acid; Fluorescence; UV/FLD Response Ratio

ICSBE24_852

INDUSTRIAL WET DYE WASTEWATER TREATMENT BY ELECTROLYSIS

U.S. Liyanarachchi[1], A.A.G.D. Amarasooriya[1*], S.K. Weragoda[2], Harshi Jayasingha[3]

[1]Department of Applied Earth Sciences, Faculty of Applied Science, Uva Wellassa University, Badulla, Sri Lanka

[2]China-Sri Lanka Joint Research and Demonstration Centre (JRDC) for Water Technology, E O E Pereira Mawatha, Meewathura, Peradeniya, Sri Lanka

[3]Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka

**Correspondence E-mail: gayan.a@uwu.ac.lk, TP: +94761026772*

Abstract: The expansion of the textile industry has created significant environmental challenges, particularly due to the high toxicity and extremely high Chemical Oxygen Demand (COD) of wet dye wastewater, which makes its treatment highly difficult. In this study, we investigated electrolysis as a novel, chemical-free technology for addressing high COD level in wet dye wastewater. A single-cell reactor with a Platinum anode, Stainless-steel cathode, and porous membrane was utilized, and key parameters; current density, pH, retention time, flow rate, and NaCl concentration were systematically optimized. Results demonstrated that increasing current significantly enhanced treatment efficiency, achieving COD removal rates of 99.54–99.68% and color removal of 79–100% for currents ranging from 25 to 200 mA. Higher NaCl concentrations improved color removal from 93% (for 5 mg/L-NaCl) to 99.98% (for 40 mg/L-NaCl), though COD removal slightly declined from 99.55% to 98.80%. Under optimal conditions (NaCl: 40 g/L, current: 200 mA, pH: 5, retention time: 72 hours, electrolysis time: 60 minutes, flow rate: 2.67 mL/min), the process achieved 99.68% decolorization and 99.97% COD reduction for wastewater with an initial COD of 89,090 mg/L. These findings highlight electrolysis as a significantly efficient and sustainable solution for textile dye wastewater treatment, addressing critical industrial challenges while promoting environmental sustainability.

Keywords: Electrolysis; NaCl; Electrodes; Textile Wastewater; Wet Dye

ICSBE24_401

NAVIGATING THE GLOBAL WATER CRISIS: SUSTAINABLE WASTE WATER TREATMENT AS A PATHWAY TO RESILIENT URBAN INFRASTRUCTURES

K.P.T. Malshani*

Department of Environmental and Industrial Sciences, Faculty of Science, University of Peradeniya, 20400, Sri Lanka

**Correspondence E-mail:tiromi95719malshani@gmail.com, TP: +94775782544*

Abstract: The need for sustainable wastewater management has been driven by the global water crisis, which has been worsened by rapid urbanization, population growth, and climate change. This paper reviews how sustainable wastewater treatment systems can help reduce water shortages, mitigate environmental degradation, and promote resilience in urban areas. Available literature showcases different approaches, including the integration of water, wastewater, and storm water systems under the "One Water" concept, for comprehensive urban water management. However, there are still research gaps in implementing these approaches across various socio-political and geographical contexts. This study aims to assess current methodologies and strategies that support sustainable wastewater management, particularly in the face of water scarcity, fast-paced development, and socio-political unrest, as evidenced in scenarios such as Lebanon's refugee crisis. By synthesizing important studies, such as those on scenario planning for resilient infrastructures and sustainable urban water practices in the USA, this paper investigates established and emerging methods. Methodologically this review analyzes case studies and scenario planning to assess how integrated urban water management can enhance resilience. The results highlight the efficacy of a "One Water" approach in improving water efficiency and sustainability, especially in urban areas struggling with acute water scarcity. Furthermore, integrated humanitarian-development procedures have shown the ability to strengthen infrastructure systems during prolonged disasters, as observed in Lebanon. Findings indicate that cities that adopt resilient wastewater management practices are less liable, to water shortages and climate impacts, thereby promoting long-term sustainability. In summary, while improving urban resilience through sustainable wastewater treatment is a promising path, future research should focus on adapting these models to diverse urban.

Keywords: Sustainable Wastewater Treatment; Urban Water Resilience; Global Water Crisis; One Water Approach

ICSBE24_099

RUBBER INDUSTRY WASTEWATER PRE-TREATMENT USING MAGNETIC SEED COAGULATION METHOD

S.A.T.U. Senevirathna[1*], W.D.I.M. Somathilake[1], K.B.S.N. Jinadasa[2], K.G.N. Nanayakkara[1]

[1]Department of Civil Engineering, University of Peradeniya, Peradeniya 20400, Sri Lanka
[2]School of Engineering and Technology, Central Queensland University, Brisbane QLD 4000, Australia
**Correspondence E-mail: e18328@eng.pdn.ac.lk, TP: +94777648470*

Abstract: This study developed a pre-treatment method using magnetic seed coagulation to reduce the strength of natural rubber industry wastewater (NRIWW) by effectively lowering suspended solid concentrations. As high-strength rubber wastewater contains significant amounts of suspended solids, turbidity, ammoniacal nitrogen (NH_3-N), and other inhibitory substances, effective pre-treatment is very significant to ensure the smooth functioning of secondary or tertiary treatment processes. Centrifuged latex-producing industry wastewater was treated using magnetic seed coagulation method, employing Poly-aluminum chloride (PACL) as a coagulant, Polyacrylamide (PAM) as a flocculant, and magnetic seed (MS) (Fe_3O_4 - ferro ferric oxide) as a densifier and adsorbent. The experiment was performed at a pH of 6.5, investigating the effect of PACL, PAM, and MS dosages on total suspended solids (TSS), ammoniacal nitrogen, and turbidity removal efficiencies. Response surface methodology (RSM) and face-centered central composite experimental design (FCCD) matrix were used to design the experiments, while the data was analysed using analysis of variance (ANOVA). The findings revealed that the method had relatively low efficiency in the removal of ammoniacal nitrogen(standard deviation of 411.5). The total suspended solids and turbidity which are the most significant characteristics that should be treated in a pre-treatment process to enhance the efficiency of post-treatment were effectively reduced by the present work. The optimisation was mainly focused on the desired TSS discharge concentration of 50 mg/L as per the accepted standards of Sri Lanka. The optimal dosages of MS, PACL, and PAM were identified to be 20 mg/L, 400 mg/L, and 25 mg/L, respectively. This study highlights that magnetic seed coagulation has the possibility to be used as a pre-treatment method to enhance the efficiency of wastewater treatment processes in the natural rubber industry.

Keywords: Natural Rubber Industry Wastewater; Pre-treatment; Magnetic Seed Coagulation; Optimisation

ICSBE24_691

ECO-CONSCIOUS GROWING MEDIA PELLETS FOR URBAN GARDENS MADE FROM RECYCLED WATER TREATMENT SLUDGE

H.H.S. Kawshalya[1], Pradeep Gajanayeke[1], Dasuni T. Bandaranayakab[2], Y.G.D.P. Wijewardana[3]

[1]Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka

[2]Research Centre for Eco-Environmental Sciences, University of Chinese Academy of Sciences, China

[3]Faculty of Graduate Studies, University of Colombo, Sri Lanka

**Corresponding E-mail: pradeepgajanayake@sjp.ac.lk, TP: +94771522444*

Abstract: Drinking water treatment sludge (DWTP) is the solid or semisolid-like by-product produced during mainly the sedimentation process in the water purification process. The sludge is commonly content with nutrients and organic matter and it has the potential to be used as a growing media. This study aims to introduce the growing media (pellets) from the DWTP for urban gardens. The present study was conducted with, 7 types of pellets used with commercial pellet (T0) as a control treatment, and the rest were prepared using a mixture of water treatment sludge, coir dust, coir fiber, and active charcoal (T1- Coir dust and water treatment sludge, T2- Coir fiber and water treatment sludge, T3 and T4- Active charcoal and water treatment sludge, T5- Coir dust, active charcoal, and water treatment sludge, T6- Coir dust, Coir fiber, Active charcoal, and water treatment sludge) with different ratio based on the weight, then mixed with water properly and compress it and made as a pellet. The most preferable pellet was identified by using the plant growth performance of the Chili (Capsicum annum.-MI-2) and the best mean results were recorded in the T5 pellet as plant height of 7.2 cm, Number of leaves of 7, length of the leaves of 3.9 cm, length of the root 6.8 cm at the 28 days after sowing. Meantime, other tested pellets also showed good performance and among them, the T1 pellet showed the same performance as the commercial product. Based on the results of this study the T1 pellet shows the same characteristics as the commercial product and the T5 pellet shows better performance than the commercial product with cost effectiveness than the commercial product. Thus those pellets have to be used as a sustainable sludge management strategy.

Keywords: Alum Sludge; Growing Media; Growing Pellets; Pellet Development; Sustainable Sludge Management; Water Treatment Sludge

ICSBE24_501

OVERCOMING LIMITATIONS OF DIRECT CURRENT ELECTROCOAGULATION THROUGH APPLICATION OF ALTERNATING CURRENT

R.D.P. Nadun I. Ranepura, Ajith C. Herath*
Department of Chemical Sciences, Rajarata University of Sri Lanka, Mihinthale, Sri Lanka
**Correspondence E-mail: ajithch037@gmail.com, TP: +94774692681*

Abstract: Electrocoagulation (EC) has been a promising sustainable approach in waste and drinking water treatment technology. Higher pollutant removal efficiency, simplicity, cost-effectiveness and being environmentally benign hence green are the attributes of EC. Conventional Direct Current Electrocoagulation (DCEC) includes drawbacks such as passivation of electrodes, scaling on electrodes, and higher dissolution of electrodes. The Alternating Current Mode Electrocoagulation (ACEC) has become an alternative approach for addressing these issues. The EC was tested for Al-Al and Fe-Fe electrode systems at different frequencies of alternating current for synthetic hard water composed of Ca^{2+} and Mg^{2+} giving conductivity of 1000 μScm^{-1}. The effect of Current density and frequency was optimized for the highest removal of hardness. It was found that increasing frequency decreases electrode dissolution and pH of the medium during the EC process. The Al-Al electrode system was found to be the best compared to that of the Fe-Fe system. Under the optimum conditions of 14.00 V and 300 Hz during 90 min. EC time period, the removal efficiency was 80 % of Ca^{2+} and 70 % of Mg^{2+}. It was also observed that the weight loss of Al electrodes under DCEC and ACEC was 80.4 mg and 18.5 mg respectively. DCEC resulted in a dominant pitting corrosion of Al electrodes compared to uniform less surface dissolution under the application of AC. Further, it was noticed that the scaling of coagulated products was limited under ACEC while in DCEC resulted higher scaling. This study reveals that ACEC finds solutions to overcome most of the problems that arise in DCEC.

Keywords: Electrocoagulation; Alternating Current; Direct Current; Water Treatment; Green-Chemistry; Hardness

ICSBE24_050

DETERMINATION OF WATER QUALITY VARIATION IN TEMPORAL AND SPATIAL DISTRIBUTION IN NILWALA RIVER, MATARA, SRI LANKA

R.V.P.C. Jayani*, T.D. Denagama
University of Vocational Technology -No 100, Kandawala Road, Rathmalana
**Correspondence E-mail: rvpcjayani@gmail.com, TP: +94719223356*

Abstract: This study investigates the spatial and temporal variations in water quality of the Nilwala River, Matara, Sri Lanka, focusing on identifying critical periods and locations of water quality degradation. Water samples were collected monthly from January to June 2024 at ten designated sites along a 9 km stretch of the river, and analyzed for key parameters including pH, Color, Turbidity, electrical conductivity (EC), Total Dissolved Solids (TDS), Temperature and fecal coliform levels. The results highlight significant seasonal variations, with the highest levels of pollution observed in May and June due to heavy rains causing increased runoff and sedimentation. Spatially, the downstream section (Location 1) exhibited the highest levels of contamination, largely influenced by seawater intrusion at the estuary mouth of the Nilwala River, which significantly impacted water quality. Middle stream locations, particularly Locations 6 and 8, showed notable water quality degradation for some parameters due to urbanization and associated activities. These areas had elevated levels of pollutants, suggesting that urban runoff and waste discharge are significant contributors to water quality deterioration. In contrast, the upstream locations, especially Location 10 near Deniyaya, demonstrated relatively better water quality, with many parameters within permissible limits. This indicates that the upper reaches of the river are less affected by anthropogenic activities and are more suitable for drinking water with minimum treatments. The findings suggest that according to the water quality parameters were tested the better water within drinking water standard can be find in the upper reaches of the river, where pollution levels are minimal. The study highlights the need for continuous monitoring and implementation of targeted pollution control measures to safeguard the river's water quality.

Keywords: Nilwala River; Temporal; Spatial; Water Quality

ICSBE24_219

ENCOURAGING THE USE OF AUGMENTATIVE ALTERNATIVE COMMUNICATION (AAC) SYSTEM TO IMPROVE THE COMMUNICATION ABILITIES OF CHILDREN WITH UNIQUE NEEDS

P.K. Wijesekara*
General Sir John Kotelawala Defence University, Sri Lanka
**Correspondence E-mail: pearlwijesekara@kdu.ac.lk, TP: +94779876973*

Abstract: When it becomes challenging to support the communication development of special needs children, those who struggle with communication turn to innovative technologies for alternate answers. Since, researches have revealed that teachers, parents, and therapy doctors struggle with time constraints when it comes to helping special needs children in Sri Lanka improve their literacy skills, Hence, the study's aim is to investigate whether it is possible to support special needs children's use of AAC to enhance their cognitive abilities of communication. "The present study on children with learning difficulties, including autism, cerebral palsy, and Downs syndrome, falls under the umbrella of special needs of children". The AAC offers specialized techniques to help people with severe aphasia successfully to extend their communication skills in a variety of contexts, including the hospital, rehabilitation, and home. A structured questionnaire is used to collect information to evaluate the unique needs of children's speaking abilities. A sample was chosen from the LRH and AYATI Centre of education therapy clusters. Collected data is critically analyzed considering the mixed research methodology. According to the findings, every respondent suffers from a hereditary condition; the vast majority (98 %) had cerebral palsy and learning difficulties. Additionally, it was discovered that the majority of children (60 %) are positioned by their lack of communication abilities for fulfill their fundamental needs who are presented by LRH. Further it was found that 37 % of the children who use AAC are able to accomplish the essential communication abilities to fulfill their basic needs. Also, 12 % of kids are better than LRH respondents; it's thankful to AAC for a 50 % increase in communication skills for those who presented by AYATI Centre. Accordingly, the study suggests that in order to enhance the communication abilities of children with special needs, LRH should also promote the use of the AAC. It is also advised to keep providing sufficient training on AAC for physicians, educators, and parents, as well as to expand the infrastructure and subscription services required for AAC.

Keywords: Use of the AAC; Communication Abilities; Special Needs of Children; Innovative Technologies

ICSBE24_621

A REVIEW OF CURRENT TRENDS, CHALLENGES AND FUTURE DIRECTIONS OF STRUCTURAL HEALTH MONITORING TECHNIQUES IN CIVIL ENGINEERING STRUCTURES

E.M.R. Ekanayake*, J.A.S.C. Jayasinghe, A.J. Dammika, U. Jayasinghe
Faculty of Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: e16095@eng.pdn.ac.lk, TP: +94778638848*

Abstract: Over the past couple of decades, Structural Health Monitoring (SHM) has been considered one of the essential elements in maintaining civil engineering structures, such as bridges, dams, and chimneys, safe and durable. The traditional SHM methods can hardly realize the accuracy of damage identification or forecasting at the required time. New technologies such as sensor technology, Digital Twin (DT) and Computer Vision (CV) bring new hope to defeat these challenges. This review puts an emphasis on the inclusion of DT, CV and sensors into SHM frameworks. DT provides dynamic, real-time modeling of physical structures. This allows simulation under various states of structural behavior. CV enhances crack detection with the help of Unmanned Aerial Vehicles (UAVs) and Deep Learning (DL), enhances damage classification, and improves defect quantification. This paper assembles recent research into these technologies with a focus on their application within SHM. It will review some of the particular technical challenges associated with real-time data acquisition, sensor data integrated with visual input, and integration complexity in Finite Element Method (FEM) models for predictive maintenance. Finally, this paper will conclude current trends, challenges and future developments in DT, CV and sensor technologies of SHM in terms of detecting damage at its early stages with high precision.

Keywords: Civil Engineering Structures; Computer Vision; Digital Twin; Sensor Technology; Structural Health Monitoring

ICSBE24_622

DAMAGE DETECTION OF CONCRETE BEAMS USING VIBRATION RESPONSES AND ARTIFICIAL INTELLIGENCE TECHNIQUES

S.P.D. Danushka[1*], M.A.K.M. Dharmasiri[2], A.J. Dammika[1], J.A.S.C. Jayasinghe[1]
[1]Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka
[2]Earthquake Research Institute, The University of Tokyo, Tokyo, Japan
**Correspondence E-mail: dilandanushka@eng.pdn.ac.lk, TP: +94765336754*

Abstract: Health monitoring of structures is essential to maintain optimal performance during their service life. The main classical structural health monitoring techniques are visual inspections and non-destructive testing. As classical methods have limitations, vibration-based damage detection has become popular among researchers. However, vibration-based techniques have challenges arising from data inaccuracies due to noise and other environmental factors. Advances in computational power have enabled the use of various techniques to overcome these challenges. In this context, vibration-based damage detection of simply supported concrete beams using measured acceleration responses is proposed by incorporating Artificial Intelligence (AI) techniques. The beam was numerically simulated using *ABAQUS*. The acceleration responses were obtained through dynamic implicit time history analyses. Frequency responses of the beam were extracted using the Fast Fourier Transform (FFT) of the numerical acceleration responses. 3500 multiple damage scenarios were numerically simulated by altering the elastic modulus to create a database of acceleration responses. The damage locations and the damage severity of the beam were identified using Artificial Neural Networks (ANN), particularly Convolutional Neural Networks (CNN) and Multi-Layer Perceptron (MLP). The inputs to the ANN consisted of Frequency Response Functions (FRFs) measured at eleven locations on the top surface of the beam. The damage severity, the target output of the ANN model, was computed as the percentage deviation of the elastic modulus of the damaged beam compared to the undamaged beam. The coefficient of determination (R^2) for training, testing and validation data sets of CNN and MLP models were 0.99 and 0.95 respectively. According to the R^2 values of the machine learning models, the CNN using the Tanh activation function demonstrated higher accuracy across the training, testing, and validation sets compared to the MLP model.

Keywords: Artificial Neural Network; Damage Detection; Elastic Modulus; Fast Fourier Transform; Multiple Damage

ICSBE24_623

DEEP LEARNING-DRIVEN CRACK DETECTION IN COMPOSITE CONCRETE STRUCTURES WITH MULTIPLE DAMAGE SCENARIOS USING MODAL CURVATURE ANALYSIS

R.A. Dihan*, M.P.G.K. Peiris*, Kasun Dharmasiri, A.J. Dammika, J.A.S.C. Jayasinghe

Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Corresponding authors: e18080@eng.pdn.ac.lk, TP: +94761819995*

Abstract: Accurate damage detection in composite concrete structures, particularly in identifying material degradation, crack formation, and corrosion, is essential for maintaining structural integrity. This research introduces an innovative Deep Learning (DL) - based approach to detect and assess cracking behavior within composite structures using vibration data. The vibration signals were processed and transformed into modal curvature data, which were then used to train the DL model. A Finite Element Method (FEM) - based data generation technique was employed to create synthetic data for training, enhancing the model's robustness. The DL model achieved 98 % training accuracy and 95 % validation accuracy, with minimal loss of 0.0002, demonstrating its precision in identifying multiple cracking scenarios. The use of FEM - generated synthetic data reduced the reliance on extensive real-world data while maintaining high performance, making this approach highly scalable and adaptable. This study underscores the potential of DL models in Structural Health Monitoring (SHM) systems for composite concrete structures, emphasizing the significance of vibration-based modal curvature analysis, FEM - based data generation, and advanced predictive modeling for real-time, proactive damage detection. The proposed methodology provides a reliable and scalable solution to ensure the safety and longevity of critical infrastructure.

Keywords: Damage Detection, Crack Formation, Vibration Data, Composite Structures, Deep Learning, Modal Curvature Analysis, Finite Element Method

ICSBE24_624

SMART TECHNOLOGIES FOR SUSTAINABLE URBAN DEVELOPMENT: A REVIEW ACROSS SIX KEY SECTORS

G.S.P. Wickramanayake[1], A.M.S.N. Abeysinghe[2*], S.B. Dayawansa[3]
[1]Department of Civil Engineering, Faculty of Engineering, Sri Lanka Institute of Information Technology
[2]Department of Civil Engineering, Faculty of Engineering, University of Peradeniya
[3]Department of Electronics and Telecommunication, Faculty of Engineering, University of Moratuwa
**Correspondence E-mail: sathira.a@sliit.lk, TP: +94702256021*

Abstract: This study investigates the pivotal role of smart technologies in enhancing sustainability across six key areas: building and infrastructure, energy management, transportation, urban planning, wastewater management, and water management. These technologies are reshaping the urban landscape, addressing critical challenges such as resource depletion, pollution, and congestion while fostering resilience and efficiency in city systems. In the realm of building and infrastructure, smart technologies enable the integration of automation, real-time monitoring, and advanced analytics to optimize resource use, enhance structural safety, and improve energy efficiency. Similarly, energy management systems leverage smart grids, renewable energy integration, and AI-driven analytics to optimize energy distribution and consumption, significantly reducing the carbon footprint. In transportation, advancements such as Intelligent Transportation Systems (ITS), Internet of Vehicles (IoV), and Autonomous Vehicles (AV) contribute to traffic flow optimization, emission reduction, and road safety. Urban planning is increasingly data-driven, using smart technologies for real-time monitoring, resource management, and environmental protection. In water and wastewater management, the use of Artificial Intelligence (AI), machine learning, and Internet of Things (IoT) enables real-time monitoring of water resources, improves distribution and treatment efficiency, reduces energy use, and enhances environmental compliance. By utilizing data analytics, predictive systems, and advanced technologies, smart cities can address sustainability challenges and create long-term, resilient urban infrastructures.

Keywords: Smart Cities; Sustainability; Energy Management; Intelligent Transportation; Water Management

ICSBE24_678

BIOMIMICRY INSPIRED TOURISM: A PATHWAY TO DEVELOPING SRI LANKAN TOURISM INDUSTRY: A SYSTEMATIC REVIEW

K. Hemachandra[1*], U.T.G. Perera[2], W.P.I.N. Weerasinghe[2], R. Dissanayake[3], M. Senanayaka[4]

[1]Global Disaster Resilience Centre, Huddersfield Business School, University of Huddersfield, Queensgate, Huddersfield, HD1 3DH, UK
[2]Department of Geography, University of Colombo, Colombo, Sri Lanka
[3]Department of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka
[4]Department of Political Science & Public Policy, University of Colombo, Colombo, Sri Lanka
**Correspondence E-mail: k.hemachandra2@hud.ac.uk, TP: +441484258977*

Abstract: The tourism industry is a core contributor to the economic development in Sri Lanka. Among its multiple benefits, the tourism industry contributes to several negative consequences specifically for society and the environment. To avoid such negative impact and reap its full potentials in terms of economic, social and environmental benefits, Sri Lankan tourism industry needs innovative mechanisms while minimising its negative effects. Hence, this study was conducted to identify biomimicry models, practices and processes adapted in tourism industry and identify the benefits of such practices, process and models and identify any barriers for introducing biomimicry into tourism. With this intention, the study conducted a systematic literature review as the initial stage of a long-term study. The systematic literature review was based on 21 peer reviewed papers screened following the PRISMA model. The study revealed that biomimicry concepts have already been incorporated into the tourism industry in several tourist destinations worldwide. However, most practices and processes have been incorporated into the hotel design stage. Among the identified benefits, biomimicry models practices and processes attracted more tourists and further created niche markets. The study further revealed that those practices have been incorporated mostly in high-end tourist hotels and tourism activities. The research findings provide insightful messages for policymakers and industry operators to understand the power of innovative tourism strategies, and opportunities for incorporating biomimicry concepts targeting better performance while preserving the environment. The study emphasised the necessity of conducting further studies in the filed of biomimicry led tourism in collaboration with academia.

Keywords: Biomimicry; Tourism; Sri Lanka; Nature-based

ICSBE24_997

A COMPREHENSIVE REVIEW OF NATURE-INSPIRED SOLUTIONS FOR ENHANCING BUILT ENVIRONMENT RESILIENCE IN DISASTER RISK REDUCTION

P.L.C. Perera[1*], A. De Silva[2], N. Dias[2], R. Dissanayake[3], C. Abeynayeke[4], D. Amaratunga[2], R. Haigh[2]

[1]Department of Agricultural Engineering and Environmental Technology, Faculty of Agriculture, University of Ruhuna, Sri Lanka
[2]Global Disaster Resilience Centre, School of Applied Sciences, University of Huddersfield, UK
[3]Department of Civil and Construction Engineering, Curtin Colombo, SLIIT International, Sri Lanka
[4]Department of Town & Country Planning, University of Moratuwa, Sri Lanka
**Correspondence E-mail: lakmiperera04@gmail.com, TP: +94763705037*

Abstract: In the global context, disasters are regarded as one of the major challenges in the built environment. Due to the growing population and climate change, resilient urban settings are recognized as more vulnerable to applying disaster risk reduction strategies. Therefore, novel solutions and technologies like nature-inspired solutions (NiS) can be integrated into disaster risk reduction (DRR). The knowledge gaps such as application of NiS in nature-inspired solutions related to disaster risk reduction have been identified through the literature survey. Therefore, this aims to identify the capacities of NiS for DRR in the built environment to minimize the knowledge gap using a narrative review approach. A review of existing literature identifying the NiS case studies and applications for DRR and a SWOT analysis of those case studies and applications are the objectives for achieving the aim. After 1997 is the considered time frame for this review. The qualitative exploration of the review focused on databases such as Scopus, Science Direct, MDPI, and Google Scholar as well as research articles, book chapters, thesis, and reports to extract relevant information using an eligibility criterion of title and abstract review. This study has identified 15 case studies and applications of NiS for earthquakes, floods, wind and storm hazards, and wave and tidal hazards around the world with existing strengths and weaknesses with the potential opportunities and threats for each case. The findings have identified the cost, legal and interdisciplinary technical constraints while facilitating environmental sustainability significantly.

Keywords: Biomimicry; Climate Resilience; Disaster Resilience; Natural Disasters; Built Environment

ICSBE24_662

IDENTIFYING AND IMPLEMENTING SUSTAINABLE DEVELOPMENT APPROACHES FOR THE SOCIO-ECONOMIC GROWTH OF THE MILLAVITIYA GRAMA NILADHARI DIVISION: AN ANALYSIS ON POTENTIAL PRACTICES AND STRATEGIES

I.U. Yakandawala
[1]LIRNEasia, No. 15 – 2/1, Balcombe Place, Colombo 8, Sri Lanka
**Correspondence E-mail: 22isuru22@gmail.com, TP: +94767170523*

Abstract: This study mainly focusses to identifying the potential sustainable development approaches that can be deployed among the socio-economic growth process of the Millavitiya Grama Niladhari division and discussing the possibilities of the implementing those approaches in the ground level. Background study and SWOT analysis has been used as the main methodology for the identifying the ground realities and negative and positive insights of the study area. Under the main findings of the background literature analysis and the SWOT analysis, main potential approaches have been deliberated considering the strength, weakness, opportunities and the threat in the village. As final conclusion, numerous approaches and concepts can be used for the socio-economic growth in the area such as, green economy, green agriculture, participatory development, green mineral economy, sustainable data management, green digital economy, green culture and technology, green energy, and sustainable tourism. Millavitiya has been a most suitable geographical and socio-economic entity which can be used sustainable approaches in wide range and effectively.

Keywords: Sustainable Development Approaches; Rural Development; SWOT; Green Economy; Sustainability

ICSBE24_061

EVALUATING THE EFFECTIVENESS OF BIOMIMETIC APPROACHES IN URBAN BUILDING CONSTRUCTION FOR CLIMATE CHANGE MITIGATION

R.V.A.D. Rahubadda*, U. Kulathunga
University of Moratuwa, Katubedda, Moratuwa
**Correspondence E-mail: dilrukshaashen@gmail.com, TP: +94773243860*

Abstract: The urban population is notably susceptible to extreme climate events, primarily due to the urban heat island effects. It is essential to take immediate procedures to control the emission of carbon dioxide and reduce the impacts of climate change to confirm human survival and progress. As a result, concepts such as biomimicry and sustainable strategies have grown throughout the years as the most feasible solution for urban climate change mitigation. Biomimicry involves designing solutions that take inspiration from the functional principles exhibited by organisms or ecosystems in nature. This study addresses the effectiveness of Biomimicry approaches in urban building construction as a viable solution for achieving climate change mitigation. In this study, a systematic literature review was conducted to ensure an unbiased synthesis of literature with high quality and efficiency. Given the need for in-depth understanding of the concept of Biomimicry, a qualitative research approach was employed. Additionally, expert interviews were conducted as the primary method of data collection, following purposive and snowball sampling methods to validate the findings from the literature synthesis. Finally, a qualitative content analysis was utilized as the method of data analysis in this study. As a design and innovation approach inspired by nature's strategies, Biomimicry promotes the development of sustainable architecture and urban environments, offering a possible solution for forming more resilient ecologically friendly urban built environment. This study comprehensively reviews how biomimicry is utilized in architecture to achieve efficient, sustainable built environments. It encourages a reflective approach to biologically inspired innovation to mitigate negative climate impact.

Keywords: Biomimicry; Climate Change Mitigation; Urban Built Environment

ICSBE24_004

SUSTAINABLE DEVELOPMENT RESEARCH TRENDS: A BIBLIOMETRIC ANALYSIS FROM 2000-2023

T. Wickramasinghe[1*], S.M.R.N.S.K. Asmadala[2], D.N. Jayawardhana[2], M.D.G. Sansala[2]

[1]Department of Geography, University of Peradeniya, Peradeniya
[2]Department of English, University of Peradeniya, Peradeniya
**Correspondence E-mail: tharuwicko@gmail.com, TP: +94701098411*

Abstract: Sri Lanka, a country with rich biodiversity and a cultural heritage, is now leading towards a sustainable future encompassing economic, social, political, and environmental landscapes primarily reliant on agriculture, tourism, and fishing. Policies and initiatives are implemented to achieve sustainable development by 2030 within Sri Lanka through a Sustainable Development Framework. Further, the country has made significant strides in promoting sustainable agriculture, renewable energy and eco-friendly tourism. The objective of the study is to provide a comprehensive analysis of research studies that have been done with regard to sustainable development in Sri Lanka and further to identify the gap in the existing knowledge pool of Sustainable Development in Sri Lanka. Bibliometric analysis was used in combining fractional counting to verify the core authorship network and identify the prominent sectors and highly cited publications. The network of authors, sustainability-related study sectors, core occurrences and keywords have been primarily focused and a network analysis tool available in Vos Viewer software was utilized to gain the accurate data of the research clusters, scope, and structures. Quantitative research design is used so that it connects the research to the deductive approach. 140 articles dated from 1st of January 2000 to 1st of January 2023 were found by filtering key terms from the VOS viewer software and obtained data highlighting the fact that Sri Lanka had discussed and conducted the research projects predominantly on ten main fields. This further exemplifies that many studies have been conducted on environmental sustainability accommodating a great quantity focusing on the Environmental Science section. However, areas of social and tourism sustainability are underrepresented, despite their importance for comprehensive sustainable development. The bibliometric analysis explores the state of sustainability in Sri Lanka investigating the nation's progress, challenges, and future pathways within the framework of the United Nations Sustainable Development Goals (SDGs). Social sustainability is a new trend that will be researched in the future.

Keywords: Bibliometric Analysis; SDGs; Sri Lanka; Sustainability; Sustainable Development

ICSBE24_167

TACKLING THE GLOBAL THREAT OF MICROPLASTIC POLLUTION: A CRITICAL REVIEW OF PROMISING GREEN ALTERNATIVES AND THEIR ENVIRONMENTAL IMPACT

K.A.D.P.K. Gunathilaka*, B.G.N.P. Jayasooriya
Department of Polymer Science of Faculty of Applied Sciences of University of Sri Jayewardenepura.
**Correspondence E-mail: pasangunathilake29@gmail.com, TP: +94762115816*

Abstract: Microplastic pollution has become a major environmental threat impacting ecosystems, wildlife, human health, and food chains. Estimates of annual microplastic release to the environment range from 3 to 4.8 million metric tons, including textiles (200,000-500,000tons/year) and personal care products (10,000-120,000 tons/year). Industries and researchers seek solutions to reduce microplastic harm with green alternatives and innovative concepts. This review investigates the potential of green alternatives to microplastics. It focuses on several key areas: biodegradable polymers, which decompose naturally, unlike traditional plastics; natural fibers, offering a sustainable and renewable alternative to synthetic textile materials that often contain microplastics; and novel materials derived from renewable sources, aiming to replace microplastics while minimizing environmental impact. This review identified a range of eco-friendly alternatives for various applications currently reliant on microplastics, including packaging and bottles, cosmetics, 3D printing, tyre wear, and marine coatings. Biodegradable PLA plastics can replace traditional packaging materials. At the same time, Chito beads from crustaceans are a promising alternative that exhibits a higher cleansing efficiency than conventional polyethylene microbeads and is fully degradable without toxicity. Olive stones, almond shell powder, apricot stone powder, argan shell powder, and pistachio shell powder can be used instead of microplastics used as bulking agents, pigments, and cosmetic fillers in cosmetic and other personal care products. PLA is used as an alternative filament in 3D printing and biodegradable textile fiber. The Eco silica derived from agricultural waste can reduce microplastic generation from tyre wear. Also, eco-friendly coatings derived from plant extracts and oils can replace traditional marine coatings that pollute our oceans from microplastic pollution and eco-friendly anticorrosive epoxy coating from Ixora leaf extract and antimicrobial capsaicin, Cinnamomum cassia oil coating gels are a good solution for addressing the problem. In conclusion, this review highlights the potential of green alternatives to significantly reduce microplastic pollution across various industries, the way of doing that and their manufacturing process, paving the way for a more sustainable future.

Keywords: Biodegradable; Environmental Impact; Green Alternative; Microplastics; Pollution

ICSBE24_65

EXPERIMENTAL INVESTIGATION AND ANALYSIS OF FIRE ENDURANCE OF AUTOCLAVED AERATED CONCRETE BLOCKS

P.W.A.S. Dasanayaka*, I.S.K. Wijayawardane
Department of Civil Engineering, The Open University of Sri Lanka
**Correspondence E-mail: asankascc@gmail.com, TP: +94716459251*

Abstract: This research investigates the fire resistance of Autoclaved Aerated Concrete (AAC) blocks, a lightweight building material gaining popularity. Despite its widespread use in the Sri Lankan construction industry, very few studies have been carried out on the fire endurance of AAC material, a crucial factor in construction safety. Data collection encompassed visual inspection and quantitative analysis, ensuring a robust dataset for comprehensive examination. The study primarily focused on investigating the residual mechanical properties of AAC blocks when subjected to various temperature regimes (up to 1000 °C) and exposure durations (up to 90 minutes). These conditions were applied using an electrical furnace, and the mechanical properties were evaluated using compressive strength and splitting tensile strength tests. The thermal conductivity assessment indicated that AAC blocks maintain strong insulation properties up to 300 °C. Significant structural cracks emerged at 950 °C, severely impacting thermal conductivity. The residual compressive strength analysis showed a consistent decrease with rising temperatures, with strength becoming negligible at 900 °C. The minimum required strength can be maintained up to 500 °C, with a 16 % reduction in compressive strength compared to the initial value. Splitting tensile strength tests revealed a similar trend, with residual tensile strength diminishing as temperatures increased. Specifically, the splitting tensile strength decreased by 55 % as the temperature rose from room temperature to 700 °C. Hence, the findings denote AAC blocks maintain structural integrity up to 500 °C. However, their effectiveness diminishes beyond this temperature due to significant thermal degradation.

Keywords: Lightweight Concrete; AAC; Fire Endurance; Thermal Conductivity; Compressive Strength; Splitting Tensile Strength

ICSBE24_314

EVALUATION OF SEISMIC PERFORMANCE IN STEEL MOMENT RESISTING FRAMES UNDER COMBINED FIRE AND CYCLIC LOADS: A NUMERICAL APPROACH

B.V.D.D. Tharaka, A.S. Gampalage, Y.P.K.M.W.N. Kanakarathna, J.A.S.C. Jayasinghe*, S. Bandara
Department of Civil Engineering, University of Peradeniya, Sri Lanka
**Correspondence E-mail: supunj@eng.pdn.ac.lk*

Abstract: Steel is a popular construction material due to its strength, durability, and quick construction benefits. However, its properties degrade significantly at high temperatures, making fire a significant threat to steel structures. When an earthquake coincides with a fire, the combined effects can weaken and potentially cause the failure of steel element. Therefore, to assess the structural response under combined fire and earthquake conditions, both experimental and numerical analyses can be conducted. Numerical analysis is preferred over experimental studies since experimental studies are costly and time consuming. Then, this study develops a numerical method to evaluate the seismic performance of four bay two story hollow steel moment-resisting frame under combined fire and cyclic loading. A coupled simulation methodology using Computational Fluid Dynamics (CFD) and Finite-Element Method (FEM) was employed to simulate the fire scenario, thermal analysis, and structural analysis. *PyroSim* software, the graphical user interface for Fire Dynamics Simulator (*FDS*), was used to replicate non-uniform fire scenarios, while *ABAQUS* was used for FE analysis. The thermal field is transferred from the CFD model to the FE model using the *FDS2FEM* mapping tool, allowing for unidirectional coupling. Then, thermal analysis was conducted in the FE model with data from the CFD model, followed by sequential coupling with the structural FE model. Structural analysis involved a lateral cyclic loading scenario to represent seismic action, and combined hardening was used as the hardening rule. Validation confirms the accuracy of the numerical approach, and a parametric study explored the effects of fire locations and beam flexural stiffness on seismic performance. This research revealed that fires at the column adjacent to the cyclic loading point resulted in the greatest strength and ductility losses, with reductions of 9.8% and 15.09%, respectively. Fires directly at the cyclic loading point exhibited the lowest increase in energy absorption capacity, at 10.01%. Increasing the middle beam stiffness enhances strength and energy absorption capacity but slightly decreases ductility.

Keywords: Computational Fluid Dynamics; Finite Element Simulation; Fire Simulation; Moment-resisting Frames; Seismic Responses

ICSBE24_173

ADAPTATION OF COST CONTROL TECHNIQUES FOR SMALL SCALE HOUSE CONSTRUCTION IN SRI LANKA

K.A.W. Deshan[1], Kumari Wijekoon[2], Samindi Perera[3]
[1]Liverpool John Moores University, United Kingdom
[2]General Sir John Kotelawala Defence University, Rathmalana, Sri Lanka
[3]Sri Lanka Institute of Information Technology, New Kandy Road, Malabe
**Correspondence E-mail:samindi3d@gmail.com, TP: +94768403298*

Abstract: The Construction industry is the most significant sector that contributes to the country's economy. The growing population creates the demand for housing construction and offers significant opportunities for the booming of the Sri Lankan construction industry. However, the ongoing economic crisis and the rising cost of material and labor prices have led to substantial cost overruns, affecting the construction sector's overall performance. It is crucial to identify and adopt effective cost-control techniques to benefit small-scale housing construction to navigate these challenges. This research aims to understand the cost control challenges and the need for a tailored cost control framework for small-scale housing construction. A deductive approach was employed, leveraging existing conceptual knowledge of cost control techniques in small-scale housing construction projects in Sri Lanka. An extensive literature review was conducted to evaluate current cost control techniques/practices and explore globally available strategies for their applicability to the local context. To identify the specific challenges faced in small-scale housing construction, a well-structured close-ended questionnaire survey was circulated among experienced industry professionals, and also conducted semi-structured expert interviews to propose adaptive strategies for a cost control framework. The findings reveal that global cost control strategies, identified in the literature, were already employed in the Sri Lankan small-scale housing construction sector. However, despite their adoption, significant cost overruns persist. This study highlights the need for a comprehensive cost guideline framework tailored to the unique challenges and conditions of the Sri Lankan construction industry.

Keywords: Cost Control; Cost Overrun; Economic Crisis; Small Scale Housing Construction; Sri Lanka

ICSBE24_302

FEASIBILITY OF UTILIZING DIFFERENT INOCULA FOR ENHANCED DOMESTIC BIOGAS PRODUCTION

M.A.C. Mihikalpi[1], L.M.L.K.B. Lindamulla[1*], P.I.A. Gomes[1], J.P.A. Hettiaratchi[2]
[1]Sri Lanka Institute of Information Technology, New Kandy Road, Malabe, Sri Lanka
[2]University of Calgary, Calgary, Canada
**Correspondence E-mail: lahiru.l@sliit.lk, TP: +94771329606*

Abstract: Identifying alternative, clean, and affordable sources of energy have become a top priority for the economies of both households and entire countries due to the rising costs of fossil fuels and taxes on energy sources. This study was conducted to identify the most effective inoculum for maximizing biogas production, offering a renewable and sustainable solution for waste management. The performance of two readily available inocula namely household biodigester effluent and fresh cow dung was evaluated using 500 L custom-made anaerobic digesters with canteen waste as feedstock generated in university canteens with pH of 7.6, total solid of 35.32 %, volatile solid of 96.13 % and a moisture content of 75 %. Using batch anaerobic digesters, a comparative study was carried out to assess the methane yields and biogas generation under mesophilic conditions (28–34 °C). Thirty rounds per minute were used to intermittently stir the digesters. The results showed that the two types of inoculums significantly affected the biogas production rate. After 38 days of digestion, the average daily biogas yield for the cow dung: canteen waste mixture (1:1) was 3.27 litres/day and the effluent: canteen waste (1:1) was 26.11 litres/day, respectively. The highest cumulative gas production of 992.32 litres (yield 0.132 L/kg vs.) was shown by effluent used as inoculum biodigesters. Experimental evidence indicates that Effluent can effectively adapt to new environmental conditions and substrates when used as an inoculum, making it an effective inoculum for enhancing energy recovery systems from organic municipal waste. In collaboration with the non-governmental organization Sahana Sewa, we distributed custom made household biodigesters in Gorakana to promote community development based on the study's findings. We aim to continuously improve our project and extend its impact by continuing to monitor the performance of these units and collecting data from households.

Keywords: Anaerobic Digestion; Inocula; Biogas; Renewable Energy; Cafeteria Waste

ICSBE24_311

COMMUNITY APPROACH TOWARDS MODERN WATER TREATMENT TECHNOLOGY; STUDY IN ASAMODHAGAMYAYA

J. Ketharani[1*], D.R. Samarajeewa[2], R.M.L.D. Rathnayake[1], S.K. Weragoda[2], K.B.S.N. Jinadasa[1,3], M.I.M. Mowjood[4], J.M.P.N. Anuradha[4], R. Weerasooriya[5], S.L. Schensul[6]

[1]Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Prof E.O.E Pereira Mawatha, Meewathura, Peradeniya 20400, Sri Lanka

[2]China Sri Lanka joint research demonstration center for water technology, Ministry of Water Supply, Prof E.O.E Pereira Mawatha, Meewathura, Peradeniya 20400, Sri Lanka

[3]Central Queensland University, Bundaberg, Queensland, Australia

[4]Post Graduate Institute of Agriculture (PGIA), University of Peradeniya, Old Galaha Road, Peradeniya 20400, Sri Lanka

[5]National Center for Water Quality Research, National Institute of Fundamental Studies, Kandy 20000, Sri Lanka

[6]Department of Public Health Sciences, School of Medicine, University of Connecticut, Farmington, CT, USA

**Correspondence E-mail: ketha94@pdn.ac.lk, TP: +94775144200*

Abstract: Groundwater is the main source of drinking water for the majority of the people in Sri Lanka. The prevalence of Chronic Kidney Disease of Unknown etiology (CKDu) and its hypothesized link to groundwater consumption have set a barrier to its use. This has led to significant changes in the water consumption behaviour of the society. The recent identification of CKDu patients in Central provinces highlighted the need to install water treatment units in the endemic area. Consequently, five nanofiltration (NF) plants were installed within the Minipe area to provide safe water. Among these, Asomodhagamyaya Grama Niladhari Division (GND) was selected to study the community engagement in adapting to treated water, particularly NF-treated water, and its impact on water consumption behaviour. It was identified that the awareness of CKDu is low within the community, and consumption of NF-treated water is less compared to the other areas with high CKDu prevalence, notably North Central Province. However, the identification of CKDu patients in the community has significantly influenced water consumption behavior with more people now willing to check the quality of their groundwater. Many prefer to continue using groundwater that meets drinking water standards over NF-treated water or water treated by other systems. The reduced number of NF system beneficiaries is attributed to community structure, internal disagreements, and misconceptions about the quality of NF-treated water. Educating and advising the villagers about the risks of CKDu and the importance of safe water consumption and the proven quality of the NF-treated water will likely increase the number of beneficiaries using NF system-treated water.

Keywords: CKDu; Groundwater; Water Treatment; Drinking Water Quality; Nanofiltration; Community Engagement

ICSBE24_312

A REVIEW OF HUMANITARIAN ENGINEERING DELIVERY IN AUSTRALASIA

Hope Finn*, Claire Skipper, Shameen Jinadasa, Benjamin Taylor
Central Queensland University, Australia
**Correspondence E-mail: hope.finn@cqumail.com, TP: +61449961350*

Abstract: This study aims to identify how universities within Australia and New Zealand represent Humanitarian Engineering (HumEng) through the delivery of curriculum. HumEng is an emerging field of engineering, typically aimed towards sustainable design and helping those in crisis. However, further development and professional recognition has been slowed by lack of consensus on specifics related to its role and definition. This study reviews the literature related to this debate to develop an understanding of the problem along with potential solutions. Then, a search for institutions that deliver HumEng curriculum is conducted, along with an identification of the subject offered. A keyword analysis is conducted with these subject outlines to identify the key themes covered by the various institutions. This analysis is then used to identify what consensus, or lack thereof, exists and how that relates to some of the definitions in the literature. It was found that 28 % of Australian and New Zealand institutions delivered HumEng curriculum in some format, along with thirteen common themes. Only five of these themes were generally accepted by at least 85 % of the 13 host institutions: humanitarian aid, cultural sensitivity, problem solving, communication, and sustainability. Resultingly, it was found that there is a distinct lack of consensus within universities on which themes are important for the delivery of HumEng. Additionally, even the themes that are generally accepted amongst universities do not seem to correlate to definitions put forward by the academic literature. This provides further evidence towards the inconsistencies that plague the topic development along with conversations about its place within the greater engineering sphere. Therefore, there is an important need for a unified model of HumEng that can be readily adopted by educational institutions, based on practical requirements and academic literature.

Keywords: Humanitarian Engineering, Curriculum, Engineering Education, Keyword Analysis, Thematic Analysis, HumEng

ICSBE24_315

A HUMAN-CENTRED FRAMEWORK FOR SOCIALLY-DRIVEN ENGINEERING PROJECTS

D. Brown*, B. Taylor, S. Jinadasa, S. Rockloff
Central Queensland University, 6 University Dr, Branyan, QLD, 4670, Australia
**Correspondence E-mail: d.brown@cqumail.com, TP: +61468481170*

Abstract: This paper addresses the critical gap between engineering projects and the United Nations Sustainable Development Goals (UN SDGs), proposing an integrated socio-technical framework to develop human-centred solutions for complex social challenges. The framework bridges social and technical methodologies, ensuring that engineering solutions are technically robust and deeply rooted in human context. The methodology involves a seven-step process integrating social, technical, and human-centred design approaches. It includes research, stakeholder engagement, thematic analysis, corroboration with existing literature, design input development, weighted evaluation, and technical assessment. The framework's effectiveness is demonstrated through a case study on homelessness in Australia. Results from the case study reveal the importance of holistic, integrated support services and aligning the needs of homeless individuals with Maslow's Hierarchy of Needs. The study generated design inputs addressing various well-being aspects, from basic needs to self-actualisation opportunities. A weighted evaluation of these inputs highlighted the need for a balanced approach to addressing homelessness. The research contributes to efforts addressing the UN SDG of eliminating poverty by providing a structured approach to developing socially sustainable solutions. It emphasises the interconnectedness of social and technical disciplines in addressing complex social challenges. Recommendations include further evaluation of the framework, expanded research on homelessness, cohort analysis, model evaluation, technical feasibility assessments, longitudinal studies, and fostering interdisciplinary collaborations. This paper presents a novel approach to humanitarian engineering that promises more effective, sustainable, and socially impactful solutions to global challenges.

Keywords: Socio-technical; Human-centred; Engineering; Sustainable Development

ICSBE24_316

URBAN HEAT ISLAND EFFECT MITIGATION THROUGH BLUE-GREEN INFRASTRUCTURE: A CASE STUDY OF MELBOURNE

M.A.C. Lakmini[1*], A. Kent[1], K.B.S.N. Jinadasa[2]
[1]RMIT University, Melbourne, Australia
[2]Central Queensland University, Australia
**Correspondence E-mail: chiroshalakmini@gmail.com, TP: +61452256537*

Abstract: The Urban Heat Island Effect (UHIE) is a pressing challenge for rapidly urbanizing cities like Melbourne. This study explores the potential of integrating Blue and Green Infrastructure (BGI) to mitigate UHIE, benchmarking Melbourne's strategies against global cities such as London, New York, Chicago, and Tokyo. As cities grow denser, UHIE worsens due to increased heat retention in urban areas. Integrating green spaces with water-sensitive urban design provides a promising approach to addressing the problem, as it enhances natural cooling mechanisms through evapotranspiration and water retention. To explore the potential of BGI to mitigate UHIE, a comparative analysis of BGI strategies in five cities was conducted. The City of Melbourne's policies were reviewed alongside those of the four other cities to identify key criteria for successful BGI implementation. The research utilized secondary data from policy documents, urban planning reports, and previous studies to evaluate the effectiveness of Water Sensitive Urban Design (WSUD) in reducing UHIE. Results indicate that while Melbourne's WSUD shows promise, it is often implemented in a piecemeal fashion. In comparison, cities like London and New York employ more holistic approaches by incorporating advanced decision-support tools and socio-economic criteria. The analysis further indicated that the City of Melbourne could improve its strategies by adopting multi-criteria decision analysis tools and fostering multi-agency collaborations for BGI projects. This study highlights the need for more comprehensive BGI integration in the City Melbourne. By learning from global best practices, the city can enhance its resilience against UHIE and achieve more sustainable urban development.

Keywords: Urban Heat Island Effect; Blue-Green Infrastructure; Water Sensitive Urban Design; Climate Adaptation; Sustainable Urban Planning

ICSBE24_225

VIBRATION MEASUREMENTS OF FOOT BRIDGES USING SMART PHONE DATA

R. Purasinghe[1*], E. Ozer[2], O. Marroquin[1]
[1]California State University, Los Angeles
[2]University College, Dublin, Ireland
**Correspondence E-mail:rpurasi@calstatela.edu, TP: +353017167264*

Abstract: Structural health monitoring of bridges is essential for ensuring the safety and reliability of transportation networks, including footbridges commonly used for pedestrian traffic. The natural vibration period of bridges is a key indicator of their structural integrity, particularly under dynamic loads such as wind or seismic forces. This paper presents a preliminary study of the vibration characteristics of three footbridges with different spans, using iPhones as vibration measurement devices. Accelerometers embedded in iPhones were utilized to collect vibration data in the transverse direction of bridges, and frequency-domain characteristics were extracted. To validate the accuracy of the iPhone measurements, the data were compared with readings from a traditional MEMS accelerometer, the "Motion Node." Power Spectral Density (PSD) analysis was conducted to determine the modal frequencies of the three footbridges. The results demonstrated a strong correlation between the iPhone data and the reference sensor, confirming the feasibility of using smartphones for vibration monitoring in structural health assessments of footbridges. This study serves as a precursor to a subsequent published work on the use of iPhone-based vibration measurements for monitoring a landmark bridge, highlighting the potential of smartphones as reliable and cost-effective tools for structural health monitoring.

Keywords: Vibration Measurements; Foot Bridges; Smart Phones; Power Spectral Density Analysis

ICSBE24_190

EXPLORING THE ROLE OF NONLINEAR DAMPING IN DAMAGE DETECTION OF BEAM-LIKE STRUCTURES: A MODAL RESPONSE ANALYSIS

G.B. Dissanayake*, A.J. Dammika, C.S. Bandara, J.A.S.C. Jayasinghe, P.B.R. Dissanayake

Department of Civil Engineering, Facult of Engineering, University of Peradeniya, Peradeniya, Sri Lanka

**Correspondence E-mail: gihanashantha@gmail.com, TP: +94702740922*

Abstract: This research examines the use of nonlinear, displacement-dependent damping mechanisms, notably Coulomb friction damping, on the detection and localization of structural damage within beam-like systems. By conducting a series of controlled modal analysis experiments on simply supported steel beam equipped with strategically positioned friction dampers, the study assesses the sensitivity of modal damping characteristics to the placement of energy dissipation mechanism in relation to the vibrational mode shape. Findings reveal that the influence of Coulomb damping on modal attenuation is contingent upon its proximity to regions of maximal displacement (anti-nodal points), where it exerts a significant impact, compared to nodal regions, where its effect is minimal due to reduced motion. Utilizing a parameter-optimized Variational Mode Decomposition (VMD) technique, free decay responses are decomposed into mono-frequency components, effectively isolating mode-specific damping responses under varied experimental conditions. This study underscores the intricate relationship between nonlinear damping mechanisms and mode shapes, advancing a mode-specific, baseline-independent framework for identifying damage location. These insights contribute to the development of refined structural health monitoring (SHM) strategies, providing an enhanced methodology for the precise detection and assessment of structural vulnerabilities in critical infrastructure.

Keywords: Vibration-based Damage Detection; Nonlinear Damping Identification; Instantaneous Modal Damping Ratio; Variational Mode Decomposition

ICSBE24_170

EXPERIMENTAL AND NUMARICAL STUDY ON T-SHAPED WELDED STEEL PLATES

T. Abivarna*, S. Mathushan, C.S. Bandara, J.A.S.C. Jayasinghe
Faculty of Engineeering, University of Peradeniya
**Correspondence E-mail: e18358@eng.pdn.ac.lk, TP: +94778429422*

Abstract: This study investigates SMA 400 AW steel T-shaped welded steel plates (i.e. T-stub joints) through a combined experimental and numerical approach. It focused on thick plates to understand how weld properties and residual stress influence the overall load-displacement behaviour. Two T-shaped welded specimens were fabricated using intermittent fillet welds and subjected to three-point cyclic bending loading tests until failure. Strain gauges and displacement transducers recorded data throughout the cyclic loading process to monitor the behaviour of the specimens. Further, mechanical property variation of welded parts were investigated through metallurgical analyses and hardness testing. Numerical models were developed using *ABAQUS* finite element software, simulating the experimental setup under cyclic loading conditions. Residual stresses were incorporated into the numerical model using an idealized stress pattern based on the contour method, enhancing the predictive accuracy of the numerical models. This study shows that reliable numerical models can be developed for predicting the performance of welded steel members under cyclic loading conditions.

Keywords: T-shaped Welded Steel Plates; Residual Stress; Intermittent Fillet Welds; Three-point Loading; Finite Element Analysis

ICSBE24_062

NUMERICAL SIMULATION OF PROGRESSIVE COLLAPSE OF STRUCTURES UNDER BLAST LOADS

N.T. Vandabona, P.L.N. Fernando*

Department of Civil Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: lakshithaf@uom.lk, TP: +94777202638*

Abstract: This paper presents a numerical procedure for analysing the progressive collapse of Reinforced Concrete (RC) framed structures due to blast loads, addressing the gap in current methodologies. Traditional approaches like the Alternate Load Path method, which are code-based and threat-independent, mainly focus on sudden column loss scenarios but do not fully capture the dynamic nature of blast-induced, threat-dependent collapses. This study employs a comprehensive numerical investigation using Finite Element Method where a seven-storeyed RC building is assessed for progressive collapse under blast loading. The progressive collapse analysis, focusing on perimeter blast scenarios and excluding internal explosions, is conducted with the ETABS software according to the General Services Administration's (GSA) Linear Static Procedure, using a nonlinear direct integration time history analysis for blast impact. Different blast parameters, including charge weight and standoff distances, are varied to evaluate their impact on the structural integrity of the building. The Demand Capacity Ratios (DCR) of columns are calculated to determine failure potential, with a DCR greater than 1 indicating failure. The numerical model is validated against the GSA baseline model. Blast-induced progressive collapse analysis shows significantly higher DCR values than threat-independent analyses, emphasizing the need for specialized structural design to handle dynamic blast impacts. The research identifies critical columns and potential weak points for collapse initiation where for threat-independent analysis, those directly above the removed column and on the topmost floor and for threat-dependent analysis, ground floor columns adjacent to the removed column. This study enhances the understanding of structural dynamics under blast loads and provides a framework for analysing progressive collapse in RC buildings.

Keywords: Alternate Load Path Method; Demand Capacity Ratio; Numerical Modelling; Progressive Collapse; Threat-dependent; Threat-independent

ICSBE24_103

NUMERICAL INVESTIGATION OF THE EFFECTS OF BOUNDARY WALLS ON THE WIND LOADING OF A GABLE ROOF, LOW-RISE BUILDING

M.K.D. Kavishka[1], A.U. Weerasuriya[2], C.S. Lewangamage[1]
[1]Department of Civil Engineering, University of Moratuwa, Moratuwa, Sri Lanka
[2]Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong
**Correspondence Email: dushanmkdk@gmail.com, TP: +94775281311*

Abstract: Inadequate wind load analysis often exposes low-rise buildings to significant wind damage, resulting in substantial economic losses. To address this issue, this study explores the role of boundary walls in mitigating wind-induced damages to gable roof, low-rise buildings. It aims to provide foundational guidance for constructing boundary walls that effectively reduce wind load impacts. Using Computational Fluid Dynamics (CFD) simulations, the research examines the influence of various boundary wall configurations on pressure distribution around such buildings. A total of twenty-six CFD models were developed and simulated, focusing on wind directions at 0^0 and 90^0. These models encompass two distinct boundary wall arrangements (arrangement-1 and arrangement-2), two distances from the building (d/H = 1 and 2), and four wall heights (h/H = 0.33, 0.67, 1.00, and 1.33) relative to the building's eave height (H). Model creation and meshing were performed using ANSYS Gambit, while ANSYS Fluent was employed for CFD simulations. The study primarily evaluated pressure coefficients (C_p) and uplift forces acting on the roof surfaces. The analysis revealed several critical insights. Regarding boundary wall height, the uplift force on the roof was generally lower than the base model for all configurations except when h/H = 1.33. Increasing the boundary wall distance from d/H = 1 to 2 consistently reduced the uplift force on the roof. Furthermore, arrangement-1 demonstrated minimizing uplift forces compared to arrangement-2. Notably, the configuration with arrangement-1, boundary wall distance of d/H = 2, and height of h/H = 0.67 relative to the building height exhibited the lowest uplift forces on both the upwind and downwind roof surfaces. These findings underscore the relationship between boundary wall configurations, pressure distribution patterns, and uplift forces on the roof, providing valuable insights into optimizing boundary wall designs to enhance roof protection against wind-induced damages.

Keywords: Boundary Wall Arrangement; Boundary Wall Distance; Boundary Wall Height; CFD Simulations; Uplift Force

ICSBE24_158

ANALYSIS OF LAMINATED GLASS PLATES UNDER HARD BODY IMPACT LOADS

T.W.M.C. Wanigasooriya*, H.G.H. Damruwan, K. Baskaran
Department of Civil Engineering, University of Moratuwa, Sri Lanka
**Correspondence E-mail: malithc@uom.lk, TP: +94702939447*

Abstract: The construction industry faces a growing demand for sustainable and resilient materials. Laminated glass offers a promising solution, but its impact resistance requires further investigation. This paper presents a development of a Finite Element (FE) model to predict the response of laminated glass panels to hard body impacts. The primary objective is to simulate the impact response of laminated glass panels using explicit FE analysis. This includes a critical examination of existing literature on FE simulations of laminated glass under various loading conditions and the implementation of the Johnson-Holmquist (JH-2) model for accurately predicting the laminated glass response under impacts. The results of the FE analysis for mid-span deflection and maximum strain compared well with those of the experimental test results. The developed FE model allows the prediction of deflection, stress, and strain in laminated glass panels subjected to impact loads. This approach paves the way for the further development of reliable FE models for impact simulations.

Keywords: Laminated Glass; Hard Body Impacts; Finite Element Analysis; Johnson-Holmquist (JH-2) Material Model

ICSBE24_191

ASSESSMENT OF CORROSION-RELATED DAMAGES IN LOW-RISE REINFORCED CONCRETE BUILDINGS – A CASE STUDY-BASED APPROACH

G.G.T.D. Wickramathilake[1*], C. Jayasinghe[1], I.E. Ariyaratne[2]
[1]Department of Civil Engineering, University of Moratuwa
[2]Lecturer, Department of Civil Engineering, University of Moratuwa
**Correspondence E-mail: thariniwickramathilake97@gmail.com, TP: +94775291742*

Abstract: Corrosion of steel reinforcement in Reinforced Concrete (RC) buildings poses a significant risk to structural integrity, particularly in coastal and high-humidity regions. If not addressed promptly, corrosion can lead to structural weakening, reduced load-bearing capacity of the structure, concrete spalling, and eventual structural failure in RC buildings. These risks necessitate a proper and timely assessment of corrosion-related damages, which is essential to ensure the safety, stability, and durability of these buildings. This research employs a case study-based approach to investigate corrosion-related damages in low-rise RC buildings in the Southern and Western provinces of Sri Lanka. In this study, data from condition assessments of approximately 25 RC buildings affected by corrosion were collected through field investigations. A detailed database was developed, incorporating details such as building age, observed damages, and identified causative factors for these damages. The collected data was analyzed alongside relevant literature to categorize corrosion-related damages into two primary categories, damages leading to corrosion and corrosion-induced damages, each further subdivided into structural damages and non-structural damages. Contributing factors were categorized as Environmental and Moisture-Related Factors, Structural and Maintenance Factors, Material and Construction Quality Issues, and Chemical-Related Factors. This research emphasizes the need for proactive condition assessments and timely interventions to mitigate severe corrosion-related damages. The categorization developed in this study serves as a valuable reference for optimizing maintenance strategies and enhancing the durability and resilience of RC buildings in corrosion-prone regions. The findings highlight the importance of preventive measures and condition assessments in preserving the structural integrity of RC buildings over time.

Keywords: Corrosion-Related Damages; Condition Assessment; Low-Rise Reinforced Concrete Buildings; Structural Degradation; Non-Destructive Tests

ICSBE24_116

COMPARATIVE ANALYSIS OF *Xanthosoma sagittifolium* CULTIVATION IN SRI LANKA: IMPLICATIONS FOR FOOD SECURITY AND SUSTAINABILITY

W.P.T. Wijenayake[1], Sandun Bandara[1], N.D.A.D. Wijegunawardana[1*], D.A. Carole[2]
[1]Department of Bioprocess Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale
[2]Department of Plant Biology, Faculty of Science, University of Yaoundé 1, Cameroon
**Correspondence E-mail: ashawijegunawardana@gmail.com, TP: +94704352350*

Abstract: In Sri Lanka, despite the extended period of drought and unpredictable rainfall pattern patterns, extensive marginal lands in the dry zone and intermediate zone provide substantial opportunities to address the emerging issue of limited land cover. While wet zone has more favorable climatic conditions for crops, agricultural land is limited. Being climatic resilient, *Xanthosoma sagittifolium* L. Shott (*Kiri Ala*) has the potential to be cultivated in marginal lands with intercropping and undercropping cultivation practices. Sampling sites were chosen based on specific criteria: soil type, cultivation age (9 - 12 months), and a minimum distance of 2 km between sites. Samples were collected during July and August 2024. Soil parameters and agronomic growth characteristics of the plants were recorded. Additionally, a farmer survey was conducted via an interviewer-administered questionnaire to gather data on cultivation practices. *Kiri Ala* cultivation in the dry zone is a bit difficult because of the low fertility, organic matter content, and unsatisfactory rainfall distribution around 1000 to 1500 mm annually. The intermediate zone receives adequate rainfall, and neutral loamy soils enable the farming of *Kiri Ala* crops with minimal application of resources from outside the farm. Some of the traditional practices; planting under coconut trees with added benefits in terms of shade and manure from decomposing organic material, can be practiced. Our findings suggest that still government involvement is necessary for improving *Kiri Ala* cultivation practices, quality seed cultivation promotion, and awareness of its nutritional value in consumers to demand its market value. Year-round yield, high nutritional and economic value with low input, and ability to grow in marginal zones with intercropping and undercropping practices suggest its potential to support Sri Lankan food security and sustainability.

Keywords: *Xanthosoma sagittifolium*; Dry zone; Intermediate zone; Food Security; Sustainability

ICSBE24_091

ASSESING PESTICIDE AND FERTILIZER USAGE IN RICE CULTIVATION: A SURVEY OF FARMERS AND RETAILERS IN THE POLONNARUWA DISTRICT, SRI LANKA

H.Y.K.S. De Silva[1,2*], M. Makehelwala[1], A. Gamage[1]
[1]China-Sri Lanka Joint Research and Demonstration Center for Water Technology, Ministry of Water Supply, E.O.E. Perera Mawatha, Peradeniya, 20400, Sri Lanka
[2]KAATSU International University, Sri Lanka
**Correspondence E-mail: kethakiesandu@yahoo.com, TP: +94740011718*

Abstract: Rice is a staple food in Sri Lanka, making paddy cultivation a cornerstone of the nation's agriculture. Proper use of pesticides and fertilizers is crucial, as inappropriate usage can negatively impact the economy, health, and environment. This study focuses on the Polonnaruwa District, which was selected for its significant paddy cultivation potential. The primary aim was to evaluate current practices in pesticide and fertilizer use, identify trends, analyse sources and supply chains, and provide recommendations for improvement. The study was conducted during the Yala season of 2023, covering areas in Hingurakgoda, Madirigiriya, Thamankaduwa, and Lankapura in the Polonnaruwa District. A descriptive survey was used to gather data from farmers and pesticide retailers through questionnaires. Key areas of inquiry included farming experience, cultivation seasons, paddy varieties, cultivation area sizes, and usage patterns of pesticides and fertilizers. Results indicate that Pretilachlor, an herbicide, is the most commonly used pesticide among farmers. Fertilizer usage is uniformly composed of Urea, TSP (Triple Super Phosphate), and MOP (Muriate of Potash). The study found that farmers typically manage relatively small cultivation areas. The study provides insights into current agricultural practices and highlights the need for more efficient use of pesticides and fertilizers. Recommendations will focus on improving farming practices to enhance productivity and sustainability while mitigating negative impacts. This research aims to support the development of more effective and environmentally friendly agricultural strategies in Sri Lanka.

Keywords: Farmers Questionnaire; Fertilizer; Paddy Cultivation; Pesticides; Pretilachlor

ICSBE24_798

IMPACT OF USING MICROALGAL CONSORTIUM FOR SEED GERMINATION IN RICE PLANTS

H.A.D.R.P. Sirimanna*, A.D.S.N.P. Athukorala
Department of Botany, Faculty of Science, University of Peradeniya
**Correspondence E-mail: s18125@sci.pdn.ac.lk, TP: +94711438024*

Abstract: The intensive application of chemical fertilizers affects the environment and health. As a result, modern agriculture primarily focuses on sustainable approaches from which microbial-based biofertilizers have become handy. Using microbial biomass as fertilizer has the added advantage of slow release of nutrients while inducing plants' innate immune systems against diseases. This study investigated the effect of microalgal biomass on seed germination of three different rice varieties (*Oryza sativa*), Bw 372, Bg 357, and Ld 253. The study used a *Chlorella* sp., *Nannochloropsi*s sp., an unknown filamentous green algal species (sp. 1), and an algal consortium of the above 3 species in comparison to controls: distilled water, chemical fertilizer, and Bold's Basal Medium (BBM). The results revealed that the biomass of *Chlorella* sp. and the microalgal consortium significantly increased the seed germination rates of all three rice varieties. The length of roots and seedling stems increased in treatments within 24 hours in *Chlorella* sp. and the microalgal consortium compared to controls. The Bw 372 rice variety showed a 100% seed germination percentage in *Chlorella* sp. treatment and 96% in microbial consortium treatment; Bg 357 showed 96% in both treatments, and Ld 253 indicated 68% and 80%, respectively. Bw 372 showed the best seed germination percentage in *Chlorella* sp. and algal consortium treatments. Compared to results from algal treatments, chemical fertilizers showed lower activity in seed germination. This study suggested that microalgae treatments exhibited a high seed germination rate, revealing the microalgae's potential as biofertilizers in rice cultivation.

Keywords: Biofertilizer; Microalgal Consortium; *Chlorella* sp.; *Nannochloropsis* sp.; Seed Germination; Rice Plant

ICSBE24_820

POTENTIAL USAGE OF LIQUID PHASE OF SEWAGE SLUDGE PRODUCED USING HYDROTHERMAL CARBONATION FOR AGRICULTURAL PURPOSES

Wathsala Sriyananda[1], S. Sajitthan[3*], Udara Welagedara[2], I.M.W.K. Illangasinghe[1,3], E.P. Rajapakse[3]
[1]University of Peradeniya
[2]University of Sabragamuwa
[3]National Water Supply and Drainage Board
**Correspondence E-mail: sajitthan95@gmail.com, TP: +94777497095*

Abstract: Landfilling is the common method practiced traditionally in Sri Lanka to dispose wastewater sludge which can pose environmental risks. The Hydrothermal carbonization (HTC) process is used to convert any wet biomasses into liquid and solid phases at the temperature of 150°C-300°C and at an autogenous pressure of 2-4 MPa. This study has used the wastewater sludge from Kandy City Wastewater Treatment plant in Gannoruwa. The liquid and solid phases of wastewater sludge were produced with the HTC process using varying temperatures (150°C, 200°C, and 240°C) and retention times (30, 60, and 90 minutes). Tests were done on the liquid produced to determine its properties for the compliance with liquid fertilizer standards. Consequently, a seed germination test was carried out to identify the phytotoxicity prior to use as a liquid fertilizer. The liquid phases from each test condition were analysed against Sri Lankan fertilizer standards (SLS 1702:2021) for pH, EC, total N, P, K, Salmonella, fecal coliform, and heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, and Zn). The seed germination study was carried out using Tomato (Solanum Lycopersicon) seeds. The liquid phase of each test condition applied directly as it is and diluted (1:10 ratio) with distilled water on the seeds. The liquid phase of HTC experiments showcased satisfactory results where pH ranged between 6.4 to 7.6; EC ranged from 2.9 to 7.0 dS/m. No Salmonella, fecal coliform, and heavy metals were detected. However, the Total N, P and K, which ranged from 0.0% to 0.37%, 0.03%-0.26% and 0.03% to 0.05%, respectively did not meet specified SLS standards. From the 12-day seed germination tests, the concentrated sample at 150°C at 30 mins showed better results in seed germination and grown length (11.5% increment) (almost equivalent to the control sample), and the concentrated sample at 150°C at 60 mins shows best results for shoot fresh weight (24.9% increment). The control samples used tap water and distilled water.

Keywords: Hydrothermal Carbonization; Liquid Fertilizer; Nutrients; Seed Germination; Wastewater

ICSBE24_487

ARTIFICIAL INTELLIGENCE: A TECHNOLOGY FOR FRUIT QUALITY INSPECTION AND MONITORING IN SUSTAINABLE AGRICULTURE

J.A.T.N. Jayasooriya*, M.G.G. Awanthi
Department of Agriculturale Engineering and Environment Technology, Faculty of Agriculture, University of Ruhuna, Matara, 81100, Sri Lanka
**Correspondence E-mail: thilinijayasooriya3@gmail.com, TP: +94717210209*

Abstract: The technological methods of agriculture are under pressure to meet the growing demand for food production. Due to change in land usage and climate, there is also an increasing need for technology transition that try to sustaining the environment. In this context, the technological advancement of agriculture with artificial intelligence (AI), can be considered as an important approach toward sustainable agriculture. All technologies are being integrated into the entire agricultural production process, particularly in the areas of fruit quality inspection and monitoring of agricultural products for ensuring a sustainable and secure food supply. This review, provides a critical analysis of the application of AI in the inspection and monitoring process of agricultural fruit products, which can help enhance the quality of the products and diminish use of chemical in traditional inspection methods. The current study employs details retrieved from a systematic literature review articles published between the year 2015-2024 and this involves the use of intelligent algorithms, nanotechnology, microelectronic technique, spectral technology and remote data transmission for maturity classification, quality inspection, and appearance classification. For maturity classification, Al algorithms analyses changes in color, aroma, texture, and pattern during fruit ripening, which are often difficult for humans to detect. Quality inspection involves non-destructive testing for internal quality and external quality. Al algorithms, combined with spectroscopy and machine learning, have been used to classify fruit sweetness and detect internal damage. Appearance classification utilizes machine vision technology to sort agricultural products by size, shape, color, and texture, improving yield, quality, and production efficiency. Despite the advancements, challenges remain in integrating Al technologies in agricultural analysis models due to the diversity of crops and growth cycles. High costs and a lack of key technologies limit large-scale applications. However, these technologies have the potential to enhance intelligent management, improve efficiency and quality, and reduce environmental impact, contributing to agricultural sustainability.

Keywords: Agriculture; Climate Change; Artificial Intelligence; Nanotechnology; Spectral Technology; Sustainability

ICSBE24_143

FARMER'S KNOWLEDGE, ATTITUDE, AND PERCEPTION OF PESTICIDE USAGE IN ANURADHAPURA

P.K.T.M. Dharmasena[1*], R.M.K.D. Rathnayake[1], K.G.S.S. Premarathna[2], K.N.P. Madhushani[1], N.M.H.I. Nayakarathne[1], W.M.A.U.K.M. Wijesekara[1]

[1]Department of Export Agriculture, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

[2]Department of Livestock Production, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

**Correspondence E-mail: tharindudharmasena29@gmail.com, TP: +94762518532*

Abstract: Pesticides play a major role in the agriculture sector in Sri Lanka. It is important to understand the current practices in pesticide handling and disposal among farmers to promote comprehensive safety measures that protect human health to ensure hazards caused by pesticides and environmental sustainability. This study investigated the pesticide handling and disposal practices among Sri Lankan farmers. Data was collected through a self-administered questionnaire from 62 farmers in Anuradhapura district and analysed using descriptive statistics. According to the study, pesticides were widely used (66.13 %), with a preference for mixed formulations. In terms of Personal Protective Equipment (PPE), respondents reported varied usage when applying pesticides: 50 % wear hats, 35.48 % use respirators, 25.81 % wear protective boots and gloves, 14.52 % wear safety coveralls, and 12.9 % use goggles. Additionally, 32.26 % of farmers store leftover pesticides for future applications, and 3.23 % of them release the leftover solution into irrigation canals or streams, indicating a potential area of concern for environmental contamination. The disposal of empty pesticide containers varies, with the most common method being dumping them in the field (41.94 %), followed by burning them (29.03 %). Some farmers (27.42 %) retain containers for other uses, while a small fraction (1.61 %) dispose of them in common waste places. For empty pesticide packets, 54.84 % of respondents burn them, while 45.16 % dump them in the field. While most farmers understood the importance of storage and practiced some hygiene measures, there were significant shortcomings in personal protective equipment use and pesticide waste disposal. Improper storage, disposal of leftover solutions and empty containers in environmentally sensitive areas, and the mishandling of old pesticide stocks were common. These findings highlight the urgent need for target education and training programs to promote safe pesticide handling, storage, and disposal practices among farmers. There is pressing need on regulatory and policy changes in pesticide misuse and safe handling for safety use of pesticides in Sri Lanka.

Keywords: Pesticide Usage; Pesticide Storage; Waste Disposal; Safe Handling

ICSBE24_145

MARKET DECISION SUPPORT SYSTEM FOR SMALL HOLDER PEPPER FARMERS: A CASE STUDY

H.K.S. Chathurangi[1*], B.G.V. Lakshani[1], G.A.N. Dilthusha[1], P.G.D. Nadeeshika[1], N.P. Kuruppu[1], M.W.S.G. Lakshitha[1], D.A.M. De Silva[1], B.T.G.S. Kumara[2], K.P.T. Mudalige[2]

[1]Department of Agribusiness Management , Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka

[2]Department of Computing & Information Systems, Faculty of Computing, Sabaragamuwa University of Sri Lanka

**Correspondence E-mail: sachinichathurangi4@gmaill.com, TP: +94717032565*

Abstract: Pepper (*Piper nigrum*) is a vital Sri Lankan crop, prized for its flavor enhancement and medicinal applications worldwide. Crop mainly cultivated in low and mid country landscapes and wet and intermediate agro-climatic zones while strengthen the household economy. Fragile supply chain, information asymmetry, sharp price fluctuations and heavy dependency on mid-stream actors badly affected on smooth functioning of the pepper supply chain. Simultaneously, buyers struggle to find compatible, high-quality pepper at competitive prices. Objectives of the study were to find out the existing market decision support mechanisms for small holder pepper farmers, identify the problems and limitations and to develop market Decision Support System (DSS). The DSS has primary objectives; enhance farmer's decision-making by providing real time information on good cultivation practices, strategic resource management, climate and price information, buyer preferences, while improve market transparency by enabling buyers to access detailed information on district level prices, volumes available. Knowledge on good agriculture practices and technical support on pest and disease management and advice from experts aim to strengthen the DSS. Filed visits and in-depth interviews with key informants feed the primary data requirements and secondary data on prices, volumes and climate feed the data requirements. The system will comprehend details from farmers in this region, with plans for future expansion. The DSS offers farmers critical insights into buyer details, including preferences, contact information, and purchase history, together with tools for managing pests and diseases to upgrade the cultivation strategies. DSS facilitate buyer through available volumes, type of pepper, green, black and white, types of sellers and farm gate prices, Furthermore, new farmers can access a wealth of information on best practices and expert experiences. This market-centric approach is committed to reducing ineffectiveness, improving farmer incomes, and enhancing buyers' access to high-quality pepper, with field trials demonstrating its effectiveness and expandability across Sri Lanka.

Keywords: Decision Support System; Pepper Market; Smallholder Farmers; Sri Lanka

ICSBE24_147

BUSINESS STRATEGY ANALYSIS OF THE AGRICULTURE STATE OWNED ENTERPRISES (SOEs) OF SRI LANKA

M.M.S.C. Senevirathne[1*], M.A.E.K. Jayasinghe[2], A.M.S.M.R.S.G. Bandara[1], D.A.M. De Silva[1]

[1]Department of Agribusiness Management, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
[2]Department of Export Agriculture, Faculty of Animal Science and Export Agriculture,Uva Wellassa University of Sri Lanka, Badulla, Sri Lanka
**Correspondence E-mail: cssulochana9@gmail.com, TP: +94713631454*

Abstract: State-Owned Enterprises (SOEs) in Sri Lanka's agricultural sector, established with central government capital investment, were designed to foster sustainable business models that empower the local economy. However, many SOEs have underperformed, accumulating substantial losses and destabilizing public finances. The present study explores the current status of agriculture SOEs, analyzing their business models, strategies, and challenges. There are more than 50 agriculture SOEs, including enterprises focused on livestock, paddy, and plantation management. The study utilized data from 22 agriculture SOEs. A mixed-method approach was employed, using both secondary data and primary data from key informant interviews. The study provides insights into asset management, business strategies, and performance, calling for urgent reforms in governance and management to enhance sustainability. Their assets, which comprise significant land, machinery, and buildings, are largely underutilized or inefficiently managed. The Business Model Canvas of these SOEs highlights key components such as government funding, production activities, and resource management. However, inefficiencies in management and inadequate modernization of practices are prevalent. The enterprises' Return On Investment (ROI) remains low due to poor governance, political interference, and operational inefficiencies. Key problems identified include mismanagement, overemployment, lack of investment in modernization, and heavy reliance on public funds. Also, it could be suggested to adopt a public-people-private partnerships whereever possible as means of revitalizing these SOEs.

Keywords: Agriculture; Assets Analysis; Business Model Canvas; Performance; Problems; Sri Lanka; State Owned Enterprises

ICSBE24_197

DETERMINATION OF BEST BREED BY SORTING TOMATO SEEDLINGS USING MACHINE LEARNING

Chathurika S. Silva[1*], U.D.B. Kamantha[1], R.M.C. Niruni[1], T.M.T.N.B. Thennakoon[1], N.V.T. Jayaprada[2]

[1]Department of Instrumentation and Automation Technology, Faculty of Technology, University of Colombo, Sri Lanka

[2]Department of Agricultural Technology, Faculty of Technology, University of Colombo, Sri Lanka

**Correspondence E-mail: chathurika@iat.cmb.ac.lk, TP: +94771847833*

Abstract: The determination of the best breed among the current samples was heavily dependent on its phenotyping traits. An innovative autonomous screening approach to enhance efficiency and accuracy in phenotyping of plant breeding is a recent trend. In this study, tomato seedlings of the "Chena" variety, known for their resistance to bacterial wilt, were planted and germinated under controlled conditions. Images of seedlings, captured and were processed using YOLOv8, a high-accuracy object detection model, to extract features such as leaf area, number of leaves, and seedling height. Data augmentation techniques enhanced the dataset for training machine learning models, including K-Nearest Neighbors (KNN), Support Vector Machines (SVMs), Decision Trees, and Deep Neural Networks (DNNs). The best-performing model was used to predict vegetative growth, facilitating the identification of the most productive and resilient seedlings. The best result was achieved by KNN, with an accuracy of 83%. Overall, the results highlight its superior performance compared to traditional methods in terms of speed, accuracy, and scalability. Ultimately, the methodology recommended in this research is of paramount importance for advancing plant breeding practices in future research endeavors.

Keywords: Autonomous Screening; Phenotyping; Hybrid Cultivars; Robotics; Plant Breeding; Deep Learning

ICSBE24_198

ADVANCEMENTS OF HIGH THROUGHPUT PHENOTYPING IN PLANT BREEDING WITH ARTIFICIAL INTELLIGENCE

W.A.D. Chamodi Wedasingha[1], N.V.T. Jayaprada[1], Chathurika S. Silva[2*]
[1]Department of Agricultural Technology, Faculty of Technology, University of Colombo, Sri Lanka
[2]Department of Instrumentation and Automation Technology, Faculty of Technology, University of Colombo, Sri Lanka
**Correspondence E-mail: chathurika@iat.cmb.ac.lk, TP: +94771847833*

Abstract: Breeding for desirable characters is a key domain to improve the quality and quantity of yield. Phenotyping facilitates the selection of desirable traits of any crop. However, traditional phenotyping methods are burdened by limitations related to time, labor, and accuracy. High-throughput phenotyping methods represent a transformative approach, facilitating the swift and simultaneous assessment of numerous plant traits while efficiently evaluating large populations. High-throughput phenotyping platforms have developed rapidly, leveraging advances in robotics, imaging technology, and data analysis to measure and analyze plant traits more efficiently and accurately. This review outlines phenotyping techniques in plant breeding, with emphasis on conventional phenotyping, and high throughput phenotyping techniques. Further, it compared and contrasted the high throughput phenotyping approaches and platforms of the literature with conventional phenotyping. Finally, the way in which high-throughput phenotyping techniques have revolutionized plant breeding has been conceptually validated in terms of accurate trait characterization, faster selection cycles, and increased genetic gain.

Keywords: Crop Phenomics; Morphological Phenotyping; Plant Breeding; High-throughput; Plant Architecture

ICSBE24_003

IDENTIFICATION OF *Xylella fastidiosa*, A QUARANTINE PATHOGEN, IN SOME SELECTED PROBABLE HOST PLANTS IN SRI LANKA

J.A.D.N. Jayasinghe[1], M.H.A.D. Subhashini[2], R.S. Dassanayake[1*]
[1]Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Pitipana, Homagama, 10200, Sri Lanka
[2]National Plant Quarantine Service, Canada Friendship Road, Katunayake 11450, Sri Lanka
**Correspondence E-mail: rdassanayake@sjp.ac.lk, TP: +94767311951*

Abstract: *Xylella fastidiosa* (*X. fastidiosa*) is a gram-negative, vector-transmitted bacterial plant pathogen that causes severe disease in numerous plant species. It is responsible for xylem colonization and preventing the movement of water and minerals. While most infected plants do not show any symptoms, certain host plants with *X. fastidiosa* infections display symptoms such as leaf burning, defoliation, chlorosis or bronzing along the leaf margin, and dwarfing. In 2000, the bacterium *X. fastidiosa* was discovered in Taiwan for the first time in the Asian region. Though it was found only in Taiwan, there is possibility of *X. fastidiosa* present in Sri Lanka. In order to obtain confirm the country freedom for *X. fastidiosa*, which is required for exporting plants and plant materials to Europe and other countries, this study was conducted to investigate the presence of *X. fastidiosa* in potential host plant species. A total of 165 composite samples were taken from probable host plant species from nine different districts, including Batticaloa, Mannar, Mathara, Polonnaruwa, Monaragala, Anuradhapura, Rathnapura, Ampara, and Hambanthota. These samples were collected from within the cultivated fields or surrounding areas. These probable host plants are classified in European Union Regulation 2029/1201 of August 14, 2020. Cetyltrimethylammonium bromide (CTAB) method for DNA extraction and PCR was employed to detect the presence of *X. fastidiosa* in the collected samples using specific primers for a conserved genomic region of the polymerase sigma factor of the rpoD gene of 733 bp. For comparison purposes, the positive DNA was taken from the French collection of Plant Associated Bacteria, CIRM-CFBP. The findings indicated that none of the samples from the collection contained *X. fastidiosa*. Therefore, our results suggest that the *X. fastidiosa* may not be found in the studied nine districts.

Keywords: European Union Regulation 2029/1201; Country Freedom Status; Polymerase Sigma Factor; CIRM-CFBP

ICSBE24_669

CONSUMER PREFERENCE FOR INSTANT HERBAL PORRIDGE MIXTURE AMONG UNDERGRADUATES IN WESTERN PROVINCE SRI LANKA

K.V.I. Perera[1*], K.R.P.N. Wijerathna[1], N.M.H.I. Nayakarathne[1], M.A.E.K. Jayasinghe[2]

[1]Sabaragamuwa University of Sri Lanka, Belihuloya, Balangoda, Sri Lanka
[2]Uva Wellassa University of Sri Lanka, Badulla, Sri Lanka
**Correspondence E-mail: kviperera@std.agri.sab.ac.lk, TP: +94756462507*

Abstract: Herbal porridge (*Kola Kenda*) is prepared from various green leaves, each offering distinct health benefits, either individually or when combined with other medicinal plants. In light of contemporary hectic lifestyles favoring instant foods, this study aims to explore consumer preferences and the factors influencing the purchase intentions of instant herbal porridge. The objectives of this study are to identify customer preferences for herbal porridge, assess the preference for instant herbal porridge mixtures, and determine the factors affecting consumer purchase intention. An online survey was conducted, targeting undergraduates from the Western Province. Data were collected from 159 undergraduates over a month and analyzed using descriptive statistics. Results indicate that 84 % have tried herbal porridge before. According to the results, they consume herbal porridge occasionally (52 %), weekly (19 %), rarely (28 %), and daily (1 %). It is usually consumed at breakfast (72 %). Most of them are interested in trying instant herbal porridge, and preferences for product form vary, with powder form being popular (34 %) and cube form (27 %). They are willing to pay 100-200 rupees for one instant herbal porridge product. Health benefits and nutritional value are the primary motivators for consumption, with 65 % and 60 % of respondents, respectively. When considering factors influencing the purchase of instant herbal porridge, ingredients emerged as the most concerning factor for 44 % of respondents, followed by ease of preparation (35 %), taste (34 %), and price (33 %). These findings provide insights into the consumption behaviors and preferences of undergraduates regarding herbal porridge, which could inform marketing strategies and product development in this market segment.

Keywords: Consumer Preference; Instant Herbal Porridge; Ready Food; Western Province

ICSBE24_483

REVOLUTIONIZING PLANT DISEASE DETECTION: A COMPARATIVE ANALYSIS OF MACHINE LEARNING MODELS FOR THE DIAGNOSIS OF WHITE LEAF DISEASE IN SUGARCANE

D.S. Wickramasinghe*, G.Y. Jayasinghe
Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, Mapalana, Sri Lanka
**Correspondence E-mail: dahamisamindi@gmail.com, TP: +94774653631*

Abstract: Current approaches for detecting sugarcane diseases predominantly rely on conventional image classification models, which frequently do not meet the required precision and efficiency, resulting in delayed interventions and compromised crop health. In recent years, Deep Learning (DL) techniques have been increasingly used for the detection and classification of plant diseases. For predicting White Leaf Disease (WLD) in sugarcane, several automated systems have already been developed using different image processing techniques. This paper delivers a systematic review of the literature on machine learning methodologies applied to diagnose WLD in sugarcane. It also highlights the gaps that need to be filled as well as the obstacles and problems that has faced by the previous research projects. This study evaluated the performance of the existing DL models such as You Only Look Once (YOLO) models which are YOLOv5 and YOLOR, faster Region-based Convolutional Neural Networks (R-CNN), detection transformers (DETR), XGBoost (XGB), Random Forest (RF), Decision Tree (DT), and K-Nearest Neighbors (KNN) to recognize WLD in sugarcane crops. The evaluation findings indicate that the YOLOv5 network outperformed the other selected models, achieving a precision, recall, mean Average Precision@0.50 (mAP@0.50), and mean Average Precision@0.95 (mAP@0.95) metrics of 95 %, 92 %, 93 %, and 79 %, respectively. In contrast, DT exhibited the weakest detection performance, achieving metrics values of 69 %, 65 % and 67 % for precision, recall and F1 score, respectively. The YOLOv5 architecture has been recommended as the preferred model for detecting WLD using UAV data due to its exceptional performance and compact size of 14 MB, making it the smallest among the models considered. This review study not only emphasizes current progress in the field but also provides valuable insights for future research directions in the machine learning-based detection and classification of WLD in sugarcane.

Keywords: Deep Learning; Machine Learning; Precision Agriculture; Sugarcane; UAV Multispectral Images; White Leaf Disease

ICSBE24_216

SUPPLY CHAIN MAPPING FOR VALUE CREATION AND CAPTURE IN SPECIALITY CROPS; THE CASE OF HAZELNUT INDUSTRY IN CANADA

N. Bandaranayake[1*], S. Kiridena[2], K. Jagoda[3]
[1]*Department of Engineering Management, Faculty of Engineering, University of Peradeniya*
[2]*School of Mechanical, Materials, Mechatronics and Biomedical Engineering, University of Wollongong, Australia*
[2]*Department of Management, Gordon S. Lang School of Business and Economics, University of Guelph, Canada*
**Correspondence E-mail: namalb@pdn.ac.lk, TP: +94719544764*

Abstract: The worldwide demand for speciality crops such as hazelnuts, ginseng, hops and edamame is growing steadily as their health benefits become widely accepted. Speciality crops provide unique opportunities to create and capture value due to their limited availability. As a result, while traditionally limited to countries such as Turkey and Italy, regions such as Oregon in the USA and Ontario in Canada have started to cultivate hazelnuts motivated by their potential for capturing higher value. As local farmers find it difficult to match the demand in terms of quantity as well as quality, the demand is mostly satisfied with imports. However, significant challenges are present as limited knowledge is available on farming, processing, transportation and storage of speciality crops in these emerging sectors. Mapping and modelling provide visibility and insights into the structure and functioning of supply chains, including clarity on the processes involved, leading to the identification of opportunities to create and capture value. Additionally, mapping and modelling could help identify opportunities to mitigate risks and enhance the resilience of the supply chain, as well as strengthen ethical and sustainable sourcing. More specifically, a supply chain map for speciality crops promises to shed light not only on the location of demand centres, farms, importers, warehouses and processing facilities but also on the volumes handled by facilities and channels. Such information can guide informed choices on where to locate processing facilities, and warehouses and which transportation modes to use. Such a map can also provide insights into the shrinkage in each stage and the price differentials associated with aggregation and additional processing thus providing clarity on how to maximise returns. Through the acquisition of trade data, and interviews with multiple actors across the supply chain, the study reported in this paper developed a supply chain map for hazelnuts in Ontario, Canada. The study reveals that the hazelnut farms are small and remain distributed over a significant land area providing limited access to the few processing facilities available. The study also shows the need for consolidation of processing stages to achieve economies of scale and scope which in turn demands cooperation among farmers and processors. Furthermore, based on the preferences of users, what forms and sizes of packing to use and what level of processing to undertake to increase efficiencies in the supply chain are revealed. More broadly, the finding of this study may also offer guidance on mapping, modelling and evaluation of supply chains in countries like Sri Lanka, that aim to promote small-scale production of certain export crops such as niche spices, cut flowers and foliage.

Keywords: Supply Chain Mapping, Hazelnut Value Chain, Speciality Crops, Value Creation, Value Capture

ICSBE24_670

KINETICS AND MATHEMATICAL MODELLING OF BLACK PEPPER DRYING IN A FLUIDIZED BED DRYER

G.K. Jayatunga[1*], D. Shyamalee[2], B.M.W.P.K. Amarasinghe[2]
[1]Institutute of Technology University of Moratuwa, Homagama, Sri Lanka
[2]Department of Chemical & Process Engineering University of Moratuwa, Sri Lanka
**Correspondence E-mail: gayanij@itum.mrt.ac.lk, TP: +94777334650*

Abstract: The drying behavior of black pepper in a lab-scale fluidized bed dryer has been studied. Effects of drying air temperature, stagnant bed height, and air velocity on drying kinetics were analyzed. The drying kinetics of black pepper in the fluidized bed dryer indicated a falling drying rate period without a constant rate drying period. Experimentally determined drying kinetic data were fitted to five thin-layer drying models by nonlinear regression analysis. The performance of the models was evaluated using three statistical parameters sum of square error, root mean square error, and coefficient of determination. Statistical analysis showed that the drying behavior of black pepper in the fluidized bed dryer is best fitted to the two-compartment model. Model parameters were calculated and presented. Effective moisture diffusivity increased from 6.15×10^{-11} m^2/s to 2.73×10^{-10} m^2/s when the drying air temperature was increased from 45 °C to 75 °C.

Keywords: Black Pepper; Drying Kinetics; Effective Moisture Diffusivity; Fluidized Bed Dryer; Thin Layer Models

ICSBE24_655

EXAMINING THE DROUGHT ADAPTATION STRATEGIES: A CASE STUDY IN PADAVIYA DS DIVISION

R.A. Dias*, K.M.S.M. Bandara
Rajarata University of Sri Lanka
**Correspondence E-mail: riviniavankadias@gmail.com, TP: +94714988498*

Abstract: Drought can be defined as a natural disaster which poses significant impacts on environment, social and economy. As this disaster is a major issue in 21st century it poses large scale issues in humans in every perspective. In Sri Lankan context this situation has increased in the present time period especially in the dry zone in a high manner. In this sort of background this study was done to examine the human perception of drought adaptation strategies in Padaviya ds division. This study was carried in a survey to find about the drought, drought types, drought impacts and drought adaptation strategies in Padaviya ds division and was done through a questionnaire survey and survey two was done through field observation. In the survey focus group technique was used and livelihoods were especially selected for the sample. Results of survey revealed that the majority of livelihoods were well acknowledged about the drought and its types including the impacts and identified drought as a natural disaster. Survey revealed that the hydrological drought is the most common drought to be seen in the Padaviya ds division and livelihoods use drought adaptation strategies to reduce the impacts of drought. The survey results further revealed that the livelihoods are not fully aware of the drought adaptation strategies and bethma cultivation is the most used drought adaptation strategy in the Padaviya ds division and the least used drought adaptation strategy is the chena cultivation in the Padaviya ds division. This study recommends that implementing integrated water source management, implementing agroforestry and policies and organizing awareness campaigns will also reduce the drought impact and increase human perception about drought adaptation strategies. .

Keywords: Adaptation; Perception; Drought; Livelihoods; Bethma

ICSBE24_553

USE OF COMPUTATIONAL MODELING TO OPTIMIZE THE LAYOUT OF OUTDOOR A/C UNITS IN RE-ENTRANTS OF TROPICAL HIGH-RISE RESIDENTIAL BUILDINGS

V.M. Harithkhan, I.D. Nissanka, M.M.I.D. Manthilake
[1]*University of Moratuwa-Sri Lanka, Department of Mechanical Engineering, Faculty of Engineering*
**Correspondence E-mail: harithkhanvm.20@uom.lk, TP: +94777423046*

Abstract: In tropical high-rise residential buildings, it is common to install split Air Conditioning (A/C) units for space cooling due to flexibility in operation. Often the outdoor units of the A/C's are installed in the re-entrants of the building due to aesthetic and architectural reasons. It has been observed that the heat released from the outdoor units in the re-entrant creates a hot air plume along the height of the building, creating elevated temperatures in the higher floors. The resulting elevated ambient temperatures impact the performance of the A/C units resulting in high energy use as well as equipment malfunctioning. Studies have shown that the heat column generation could be mitigated by proper layout of the outdoor units. Hence, this study focused on developing a Computational Fluid Dynamics (CFD) Simulation model to study the heat column generation effect in re-entrants of a selected apartment complex in Colombo Sri Lanka. The CFD simulations were developed to evaluate the strength of the developed heat column and its sensitivity to different re-entrant parameters and condenser layouts. The simulation results showed that the location of the condenser from the outer wall, outdoor wind conditions, and installation of perforated slab have significant impacts on the heat column generation. Relocating the condenser units towards the exterior wall proves to be the most effective solution. For the selected re-entrant shape. It was found that 1.5m from the exterior wall constitutes the optimum position for the condenser in the selected building, effectively preventing heat column generation within the re-entrant. Additionally, wind and perforated platforms play a significant role in airflow patterns and heat transfer around the building, impacting the performance of the condenser system. With the perforated platform, it was found that even the distance of 2.5 m from the wall provides a limited heat column in the re-entrant.

Keywords: Heat Column Generation; CFD Simulations; High-rise Buildings; Optimum Condenser Layout

ICSBE24_313

SENSITIVITY ANALYSIS OF INTERFERENCE EFFECTS ON INPUT WIND VELOCITIES FOR DIFFERENT HIGH-DENSITY BUILDING ARRANGEMENTS

P.M.T.N. Edirisinghe, D.P.N.A.P. Gunadasa, J.A.S.C. Jayasinghe*
University of Peradeniya, Faculty of Engineering, Peradeniya, 20404, Sri Lanka
**Correspondence E-mail: supunj@eng.pdn.ac.lk, TP: +94772209662*

Abstract: In high-density building environments, understanding the variation of interference effects with different building arrangement patterns is crucial for analysing the stability of building structures. However, most of the past studies have focused on analysing wind variation by considering a selected building arrangement or a selected city model. Therefore, in this study the variation of wind interference effect on different input wind velocities will be analysed considering different high density building arrangements using Computational Fluid Dynamics (CFD). The Reynolds-Averaged Navier-Stokes (RANS) method utilizing the 2k-ω SST (Shear-Stress Transport) turbulence model will be used in the numerical simulation to observe wind flow variations. To consider different high density building arrangements, two building arrangement types named as Category-I and Category-II, were considered and each category was defined by two non-dimensional parameters λ (The relative height of surrounding buildings to the centre building) and α (The angle of slope between the centre and edge buildings). The λ non dimensional parameter was varied from 0.05 to 1.0 and α was varied from 0 to 0.67.The Power law wind profile with reference height velocities (Vref) of 3 ms-1, 5 ms-1, 7 ms-1, 9 ms-1, and 11 ms-1 at a height of 10 m above ground, representing typical wind speeds in equatorial regions were used to analyse the sensitivity of interference effect on different Vref . In parametric study, normalized base moment was considered as an indicator of representing interference effect. Sensitivity analysis showed distinct variations in normalized base moment values for different Vref, with a maximum deviation of 6% for Category-I and 5% for Category-II. In Category-I, the maximum base moment occurred when λ equals to 0.25. For Category-II, the base moment was generally lower than isolated condition. However, stability concerns arise when the slope angle from central building to edge building is 45° to the horizontal (α = 0). These findings will be highly valuable for city designers, as they enable the optimization of building arrangements within urban environments to enhance building stability against wind interference effect. By carefully considering the heights of surrounding buildings and the critical angles formed between structures, designers can develop effective strategies to mitigate wind-induced forces. Additionally, this study concludes that the normalized base moment can serve as a reliable indicator of wind interference acting on central building, independent of the input Vref.

Keywords: CFD Simulation; Interference Effect; Turbulence Models; Urban Morphology; Wind Response

ICSBE24_555

LOW-CARBON SUSTAINABLE CONCRETE INCORPORATING GRAPHENE

Danula Udumulla*, Priyan Mendis, Thusitha Ginigaddara, Pasadi Devapura
Department of Infrastructure Engineering, University of Melbourne, Melbourne, Australia
**Correspondence E-mail: ddudumulla@student.unimelb.edu.au, TP: +61403211999*

Abstract: The cement industry, responsible for releasing 3 billion tons of greenhouse gases yearly, stands as the third-largest source of human-made CO_2 emissions, contributing 7 % to global emissions. This underscores the urgent need to explore strategies to reduce the industry's carbon footprint while enhancing concrete performance. Incorporating nanomaterials into concrete offers a promising avenue to improve material properties, reduce cement usage, and potentially lower the embodied carbon footprint of concrete structures. One such novel 2D nanomaterial, Graphene Oxide, has shown significant improvements in the strength and durability of concrete. This study examines the impact of Graphene Oxide on the mechanical properties of concrete and its potential to quantify cement reduction. The research includes a detailed analysis of various concrete grades such as G32, G40, G50, and G65. Concrete samples enhanced with GO exhibited increased compressive strength, with increments of 38 % - 45 % after 7 days and 25 % - 29 % after 28 days of curing. GO sheets were found to deflect the propagation of microcracks within the cement matrix. Using Energy Dispersive Spectroscopy (EDS), the distribution of carbon in the GO lattice and calcium hydrates in the cement matrix was analyzed, highlighting GO's role in reinforcing the concrete matrix. The study also evaluated the embodied carbon in each concrete mix, resulting in a reduction in cement utilization by up to 16 %.

Keywords: Graphecrete; Graphene Oxide; Low-Carbon Construction; Sustainability

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